

The force of the wind on the soil surface is resisted by the various soil and crop parameters. If the wind force exceeds the resistive force wind erosion will occur. If the resistive force exceeds the wind force no erosion will occur and deposition may occur if the upwind contains transported material.

DOABLE SCREEN

REVISED WIND EROSION EQUATION							
Client:		Weather File:					
		Man. File:					
Soil		Field		EF: 0.00		SCF: 0.0000	
DOABLE SCREEN							
Date	Vegetation	Operation/Event	Barrier	K'	K"	V	Period Erosion
Start							
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
/ /				0.00	0.00	0.00	0.0
Total Erosion (t/ac):						0.0	
RWEQ 97							
Press F1 Key Twice to View HELP on SPECIAL FUNCTION KEYS							

Operation dates, residue crops and/or growing vegetation, tillage/harvest operations, and wind barrier descriptions are entered in the DOABLE SCREEN.

CLIENT: _____ WEATHER FILE: _____ MANAGEMENT FILE: _____

Soil Properties:	_____	Field Geometry:	*shape	circular or rectangular	EF: _____
	soil texture	_____			
	sand	_____%	*area	_____, acres	
	silt	_____%	*orientation	_____, degrees from north	SCF: _____
	organic matter	_____%	*length_N	_____, feet	
	calcium carbonate	_____%	*slope gradient	_____	
	rock cover	_____%	*slope length	_____, feet	

Longitude	Latitude	Elevation	Annual Rainfall
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[illegible]
$$\begin{aligned}\text{Soil Loss} &= \text{_____ t/ac} \\ &= \text{_____ kg/m}^2\end{aligned}$$

CORE Values: Crop Input Data Set ¹													
Variable name		y _a	y _b	CH	SDIAM	HH	k _{ms}	k _{mf}	k _{sn}	mcf	tof	dd _o	
Residue Crop	Filename ²	Yield intercept <i>lb/ac</i>	Yield slope	Crop height <i>feet</i>	Stem diameter <i>inches</i>	After harvest height <i>feet</i>	Standing mass loss coefficient	Flat mass loss coefficient	Stem number decline coefficient	Mass/cover conversion coefficient <i>ha/kg</i>	Takeoff factor	Stem number threshold decomposition days	
Cotton	R_COTTON	400	9.25	2.0	0.4	1.8	0.0010	0.0100	0.0001*	-0.00025	4.0	45*	
Wwheat	R_WWHEAT	900	2.19	2.0	0.2	0.8	0.0013	0.0130	0.169	-0.00066	1.0	17	
Corn	R_CORN	3000	1.50	6.5	1.2	1.3	0.0010	0.0100	0.140	-0.00043	1.0	10**	
Sunflower	R_SUNFLO	0	3.60	5.5	1.0	1.3	0.0015	0.0150	0.0001*	-0.00029	1.0	45*	
Soybean	R_SOYBEA	2000	1.49	2.5	0.4	0.3	0.0030	0.0300	0.0001*	-0.00066	1.0	45*	
Oats	R_OATS	1500	1.70	3.0	0.2	0.8	0.0018	0.0180	0.284	-0.00095	1.0	17	
Sbarley	R_SBARLE	1600	1.64	2.5	0.2	0.8	0.0013	0.0129	0.176	-0.00066	1.0	17	
Wbarley	R_WBARLE	730	1.92	2.5	0.2	0.8	0.0013	0.0129	0.176	-0.00066	1.0	17	
Sorghum	R_SORGHU	1000	1.85	3.0	1.2	2.0	0.0010	0.0100	0.140	-0.00040	1.0	10	
Swheat	R_SWHEAT	1500	1.82	2.0	0.2	0.8	0.0013	0.0130	0.116	-0.00066	1.0	17	

¹ Values were provided by Schomberg and Steiner.

² Use this filename to access the file in DOS sub-directory RWEQ97.

* No data are available. The values given are assumed.

** Value is assumed to be the same as corn.

Plant Canopy Coefficients for Growing Crops¹			
Growing crop	Filename ²	Plant growth coefficient pgca	Plant growth coefficient pgcb
Cotton	G_COTTON	0.542	-3162.92
Soybeans	G_SOYBEA	0.542	-3162.92
Sorghum	G_SORGHU	0.408	-2273.16
Corn	G_CORN	0.408	-2273.16
Winter Small Grain	G_WWHEAT	- 0.463	-1577.34
Spring Small Grain	G_SWHEAT	0.508	-2577.09

¹ The equation form is $y = e^{pgca + \left(\frac{pgcb}{x^2}\right)}$

where x = days after planting and y = fraction canopy cover. The coefficients are derived from the first 75 days of growth for all but winter small grain which is from the first 60 days of growth.

² Use this filename to access the file in DOS sub-directory RWEQ97.

APPENDIX C-1

CORE Values: Tillage Input Data Set								
Implement	Filename ¹	Random roughness <i>inches</i>	Ridge spacing <i>inches</i>	Ridge height <i>inches</i>	% Flat Retained			% Standing
					Fragile	CORE	Non fragile	
Chisel-straight 2"	CHI_STR	1.50	12.0	2.0	45	70	65	70
Chisel-twisted shank	CHI_TWI	1.70	18.0	4.0		70		20
Cultivator field 6-12"	CULT_6	0.70	10.0	1.0		80		50
Cultivator field 12-20"	CULT_12	0.70	14.0	1.0	60	75	80	50
Cultivator row >30"	CULT_30	0.70	24.0	1.0		70	80	90
Disk 1-way 12-16"	DISK_12	1.20	12.0	1.0		60		25
Disk 1-way 18-30"	DISK_18	1.20	20.0	1.0	20	50	40	20
Disk large-offset	DISK_OS	1.90	0.0	0.0		50		15
Disk tandem	DISK_TAN	0.80	12.0	1.0	35	50	55	20
Drill double disk	DRILL_DD	0.30	12.0	1.0	70	90	90	40
Drill deep-furrow	DRILL_DE	0.50	14.0	3.0	60	80	75	40
Drill no-till Heavy	DRIL_NOH	0.30	12.0	1.0	45	90	65	40
Drill no-till Light	DRIL_NOL	0.40	12.0	1.0	60	90	80	40
Drill-hoe	DRILL_HO	0.75	14.0	2.0	55	50	70	40
Fertilizer appl. Heavy	FERT_H	0.60	0.0	0.0	25	50	50	50
Fertilizer appl. Light	FERT_L	0.40	0.0	0.0	50	80	80	50
Harrow spike	HARROW_S	0.30	10.0	0.5	70	80	80	0
Harrow spring tooth	HARROW_T	0.30	0.0	0.0	80	95	90	0
Harvest	HARVEST	0.00	0.0	0.0		100		100
Lister-bedder	LISTER	1.00	40.0	10.0		20		0
Moldboard 5-7" deep	MOLDB5	1.90	0.0	0.0		15		0
Moldboard 8" deep	MOLDB8	1.90	0.0	0.0		5		0
Mulch treader	MULCH_TR	0.40	0.0	0.0		85		50
Planter no-till	PLAN_NT	0.40	36.0	0.5		95		70
Planter row-double disk	PLAN_ROW	0.20	36.0	2.0		90		50
Rodweeder plain	ROD_PLA	0.40	0.0	0.0	75	90	90	50
Rodweeder shovel	ROD_SHO	0.40	0.0	0.0	65	80	80	50
Sweeps 24-36"	SWEEPS_2	0.65	36.0	2.0		85		55
Sweeps >30"	SWEEPS_3	0.50	36.0	2.0		90	85	45

¹ Use this filename to access the file in DOS sub-directory RWEQ97.

INDEX FOR WEATHER DATA FILES

AK25308.DAT	AK ANNETTE IS.	AR13814.DAT	AR BLYTHEVILLE
AK25309.DAT	AK JUNEAU	AR13963.DAT	AR LITTLE ROCK
AK25322.DAT	AK GUSTAVUS	AR13964.DAT	AR FORT SMITH
AK25323.DAT	AK HAINES	AR13977.DAT	AR TEXARKANA
AK25329.DAT	AK PETERSBURG	AR93988.DAT	AR PINE BLUFF
AK25402.DAT	AK MIDDLETON IS.	AR93991.DAT	AR WALNUT RIDGE
AK25501.DAT	AK KODIAK	AR93992.DAT	AR ELDORADO
AK25503.DAT	AK KING SALMON	AR93993.DAT	AR FAYETTEVILLE
AK25506.DAT	AK ILIAMNA	AZ03103.DAT	AZ FLAGSTAFF
AK25507.DAT	AK HOMER	AZ23104.DAT	AZ CHANDLER
AK25623.DAT	AK CAPE NEWENHAM	AZ23109.DAT	AZ TUCSON/DAVIS
AK25624.DAT	AK COLD BAY	AZ23111.DAT	AZ PHOENIX/LUKE
AK25704.DAT	AK ADAK	AZ23168.DAT	AZ GILA BEND
AK26410.DAT	AK CORDOVA	AZ23184.DAT	AZ PRESCOTT
AK26411.DAT	AK FAIRBANKS/INT.	AZ23194.DAT	AZ WINSLOW
AK26412.DAT	AK NORTHWAY	AZ23195.DAT	AZ YUMA/INT.
AK26413.DAT	AK FT. YUKON	AZ93026.DAT	AZ DOUGLAS
AK26415.DAT	AK BIG DELTA	CA03102.DAT	CA ONTARIO
AK26425.DAT	AK GULKANA	CA03154.DAT	CA CAMP_PENDLETON
AK26435.DAT	AK NENANA	CA23110.DAT	CA LEMOORE
AK26451.DAT	AK ANCHORAGE/INT.	CA23114.DAT	CA EDWARDS
AK26455.DAT	AK HUMPHREY PT.	CA23119.DAT	CA RIVERSIDE/MAR
AK26457.DAT	AK CAMDEN	CA23122.DAT	CA SAN_BERNARDINO
AK26501.DAT	AK GALENA	CA23129.DAT	CA LONG_BEACH
AK26510.DAT	AK MCGRATH	CA23131.DAT	CA VICTORVILLE/G
AK26512.DAT	AK L. MINCHUMINA	CA23136.DAT	CA OXNARD
AK26516.DAT	AK ANIAK	CA23152.DAT	CA BURBANK
AK26519.DAT	AK FAREWELL	CA23155.DAT	CA BAKERSFIELD
AK26523.DAT	AK KENAI	CA23157.DAT	CA BISHOP
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AK26535.DAT	AK INDIAN MTN.	CA23161.DAT	CA DAGGETT
AK26615.DAT	AK BETHEL	CA23174.DAT	CA LOS_ANGELES
AK26616.DAT	AK KOTZEBUE	CA23179.DAT	CA NEEDLES
AK26617.DAT	AK NOME	CA23182.DAT	CA PALMDALE
AK26620.DAT	AK MOSES PT.	CA23187.DAT	CA SANDBERG
AK26631.DAT	AK CAPE LISBURNE	CA23190.DAT	CA SANTA_BARBARA
AK26632.DAT	AK NORTHEAST CP.	CA23191.DAT	CA SANTA_CATALINA
AK26633.DAT	AK CAPE ROMANZOF	CA23196.DAT	CA CHULA_VISTA
AK26637.DAT	AK CAPE BEAUFORT	CA23199.DAT	CA EL_CENTRO
AK26703.DAT	AK GAMBELL	CA23202.DAT	CA FAIRFIELD/TRV
AK27301.DAT	AK MCINTYRE	CA23203.DAT	CA MERCED/CASTLE
AK27401.DAT	AK BARTER ISLAND	CA23211.DAT	CA SAN RAFAEL/HA
AK27403.DAT	AK OLIKTAK	CA23225.DAT	CA BLUE_CANYON
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AK27502.DAT	AK BARROW	CA23232.DAT	CA SACRAMENTO
AK45702.DAT	AK AMCHITKA	CA23233.DAT	CA SALINAS
AL03850.DAT	AL FORT RUCKER	CA23234.DAT	CA SAN_FRANCISCO
AL03856.DAT	AL HUNTSVILLE	CA23237.DAT	CA STOCKTON
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AL13896.DAT	AL MUSCLE SHOALS	CA23293.DAT	CA SAN_JOSE
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AR03930.DAT	AR JACKSONVILLE	CA24216.DAT	CA RED_BLUFF

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CA24283.DAT CA ARCATA
CA24286.DAT CA CRESCENT_CITY
CA93101.DAT CA EL TORO
CA93104.DAT CA CHINA_LAKE
CA93106.DAT CA LOS_ALAMITOS
CA93107.DAT CA MIRAMAR
CA93111.DAT CA POINT_MUGU
CA93112.DAT CA SAN_DIEGO
CA93114.DAT CA SANTA_ANA
CA93115.DAT CA IMPERIAL_BEACH
CA93116.DAT CA SAN_NICHOLAS
CA93117.DAT CA SAN_CLEMENTE
CA93193.DAT CA FRESNO
CA93209.DAT CA PASO_ROBLES
CA93214.DAT CA VANDENBERG/CO
CA93215.DAT CA POINT_ARGUELLO
CA93216.DAT CA BEALE
CO23061.DAT CO ALAMOSA
CO23062.DAT CO DENVER/STAPLE.
CO23063.DAT CO EAGLE
CO23066.DAT CO GRAND JUNCT.
CO23067.DAT CO LA JUNTA
CO23070.DAT CO TRINIDAD
CO24015.DAT CO AKRON
CO93037.DAT CO COLORADO SPR.
CO93058.DAT CO PUEBLO
CT14740.DAT CT WINDSOR/BRADL
CT14752.DAT CT HARTFORD/BRAI
CT94702.DAT CT BRIDGEPORT
DE13707.DAT DE DOVER
DE13781.DAT DE WILMINGTON
FL03815.DAT FL PENSACOLA/SAU.
FL03853.DAT FL MAYPORT
FL12804.DAT FL AVON PARK
FL12826.DAT FL HOMESTEAD
FL12833.DAT FL CROSS CITY
FL12834.DAT FL DAYTONA BEACH
FL12835.DAT FL FT. MYERS
FL12836.DAT FL KEY WEST
FL12839.DAT FL MIAMI
FL12841.DAT FL ORLANDO
FL12867.DAT FL COCOA BEACH
FL12868.DAT FL CAPE KENNEDY
FL13846.DAT FL PANAMA CITY
FL13884.DAT FL CRESTVIEW
FL13889.DAT FL JACKSONVILLE
FL93841.DAT FL MILTON
GA03813.DAT GA MACON
GA03820.DAT GA AUGUSTA/BUSH
GA03822.DAT GA SAVANNAH
GA13815.DAT GA ALBANY/TURNER
GA13829.DAT GA FT BENNING
GA13857.DAT GA VALDOSTA/MOODY
GA13860.DAT GA WARNER/ROBINS
GA13864.DAT GA MARIETTA/DOBB.
GA13870.DAT GA ALMA
GA13873.DAT GA ATHENS
GA13874.DAT GA ATLANTA
GA93801.DAT GA ROME RUSSEL
GA93836.DAT GA BRUNSWICK
GA93842.DAT GA COLUMBUS
HI21504.DAT HI HILO

HI22508.DAT HI WAHIAWA/WHEEL.
HI22514.DAT HI BARBERS POINT
HI22516.DAT HI KAHULUI MAUI
HI22519.DAT HI KANEOHE BAY
HI22521.DAT HI HONOLULU
HI22525.DAT HI PUUNENE MAUI
HI22536.DAT HI LIHUE KAUAI
IA14931.DAT IA BURLINGTON
IA14933.DAT IA DES MOINES
IA14937.DAT IA IOWA CITY
IA14940.DAT IA MASON CITY
IA14943.DAT IA SIOUX CITY
IA14950.DAT IA OTTUMWA
IA94908.DAT IA DUBUQUE
IA94910.DAT IA WATERLOO
ID24106.DAT ID MOUNTAIN HOME
ID24131.DAT ID BOISE
ID24133.DAT ID BURLEY
ID24149.DAT ID LEWISTON
ID24151.DAT ID MALAD CITY
ID24154.DAT ID MULLAN PASS
ID24156.DAT ID POCATELLO
IL03838.DAT IL VANDALIA
IL13802.DAT IL BELLEVILLE
IL14806.DAT IL RANTOUL
IL14816.DAT IL BRADFORD
IL14834.DAT IL JOLIET
IL14842.DAT IL PEORIA
IL14855.DAT IL GLENVIEW
IL14923.DAT IL MOLINE
IL93822.DAT IL SPRINGFIELD
IL93989.DAT IL QUINCY
IL94822.DAT IL ROCKFORD
IL94846.DAT IL CHICAGO/OHARE
IN13803.DAT IN COLUMBUS
IN14827.DAT IN FT. WAYNE
IN14835.DAT IN W. LAFAYETTE
IN14848.DAT IN SOUTH BEND
IN93817.DAT IN EVANSVILLE
IN93819.DAT IN INDIANAPOLIS
IN94833.DAT IN BUNKER HILL
KS03923.DAT KS WICHITA/MCCON
KS13922.DAT KS SALINA
KS13947.DAT KS FT.RILEY
KS13981.DAT KS CHANUTE
KS13984.DAT KS CONCORDIA
KS13985.DAT KS DODGE_CITY
KS13996.DAT KS TOPEKA
KS23065.DAT KS GOODLAND
KS93905.DAT KS HUTCHINSON
KS93909.DAT KS OLATHE
KS93997.DAT KS RUSSELL
KY03814.DAT KY CORBIN
KY03816.DAT KY PADUCAH
KY03849.DAT KY LONDON
KY13806.DAT KY FT.CAMBELL
KY13807.DAT KY FT.KNOX
KY93808.DAT KY BOWLING GREEN
KY93814.DAT KY COVINGTON/CIN.
KY93820.DAT KY LEXINGTON
KY93821.DAT KY LOUISVILLE
LA03937.DAT LA LAKE CHARLES

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LA12863.DAT LA BURRWOOD
LA12884.DAT LA BOOTHVILLE
LA12916.DAT LA NEW ORLEANS
LA13935.DAT LA ALEXANDRIA
LA13942.DAT LA MONROE
LA13944.DAT LA SHREVEPORT
LA13970.DAT LA BATON ROUGE
LA13976.DAT LA LAFAYETTE
MA14702.DAT MA BEDFORD/HANSC
MA14703.DAT MA CHICOPEE FALL
MA14704.DAT MA FALMOUTH/OTIS
MA14739.DAT MA BOSTON/LOGAN
MA14756.DAT MA NANTUCKET
MA14790.DAT MA S WEYMOUTH
MA94746.DAT MA WORCESTER
MD13705.DAT MD WASH/ANDREWS
MD13721.DAT MD PATUXENTRVR.
MD13752.DAT MD ANNAPOLIS
MD93720.DAT MD SALISBURY
MD93721.DAT MD BALTIMORE/FRN.
MD93733.DAT MD FT MEADE
ME14601.DAT ME BANGOR/DOW
ME14605.DAT ME AUGUSTA/STATE
ME14607.DAT ME CARIBOU/MUN
ME14610.DAT ME MILLINOCKET
ME14611.DAT ME BRUNSWICK
ME14622.DAT ME OLD TOWN/DEWI
ME14623.DAT ME LIMESTONE/LOR
ME14764.DAT ME PORTLAND/INT
MI14804.DAT MI MOUNT CLEMENS
MI14808.DAT MI OSCODA
MI14815.DAT MI BATTLE CREEK
MI14817.DAT MI CADILLAC
MI14826.DAT MI FLINT
MI14828.DAT MI GLADWIN
MI14830.DAT MI GRAND RAPIDS
MI14833.DAT MI JACKSON
MI14836.DAT MI LANSING
MI14840.DAT MI MUSKEGON
MI14845.DAT MI SAGINAW
MI14847.DAT MI SAULT STE MAR.
MI14850.DAT MI TRAVERSE CITY
MI14853.DAT MI YPSILANTI
MI14856.DAT MI GROSSE ILE
MI14858.DAT MI HOUGHTON
MI14859.DAT MI GRAND MARAIS
MI94836.DAT MI GWINN
MI94847.DAT MI DETROIT/WAYNE
MI94849.DAT MI ALPENA
MN14910.DAT MN ALEXANDRIA
MN14913.DAT MN DULUTH
MN14918.DAT MN INTERNAT.FALLS
MN14922.DAT MN MINNEAPOLIS
MN14925.DAT MN ROCHESTER
MN14926.DAT MN ST.CLOUD
MO03929.DAT MO GRANDVIEW
MO03945.DAT MO COLUMBIA
MO03947.DAT MO KANSAS CITY
MO13930.DAT MO KNOBNOSTER
MO13987.DAT MO JOPLIN
MO13993.DAT MO ST. JOSEPH
MO13994.DAT MO ST. LOUIS

MO13995.DAT MO SPRINGFIELD
MO13997.DAT MO VICHY
MO14938.DAT MO KIRKSVILLE
MS03940.DAT MS JACKSON
MS13820.DAT MS BILOXI
MS13825.DAT MS COLUMBUS
MS13865.DAT MS MERIDIAN
MS13939.DAT MS CREENVILLE
MS13978.DAT MS GREENWOOD
MS93919.DAT MS MCCOMB
MT24033.DAT MT BILLINGS
MT24036.DAT MT LEWISTON
MT24037.DAT MT MILES_CITY
MT24112.DAT MT GREAT_FALLS
MT24135.DAT MT BUTTE
MT24137.DAT MT CUT_BANK
MT24138.DAT MT DILLON
MT24144.DAT MT HELENA
MT24146.DAT MT KALISPELL
MT24150.DAT MT LIVINGSTON
MT24153.DAT MT MISSOULA
MT24159.DAT MT SUPERIOR
MT24161.DAT MT WHITEHALL
MT94008.DAT MT GLASGOW
MT94012.DAT MT HAVRE
NC03810.DAT NC HICKORY
NC03812.DAT NC ASHEVILLE/MUN.
NC13713.DAT NC GOLDSBORO/S/J.
NC13714.DAT NC FAYETTEVILLE
NC13722.DAT NC RALEIGH/R-D.
NC13723.DAT NC GREENSBORO
NC13745.DAT NC HATTERAS
NC13746.DAT NC ROCKY MOUNT
NC13748.DAT NC WILMINGTON
NC13754.DAT NC CHERRY POINT
NC13774.DAT NC WEEKSVILLE
NC13776.DAT NC LUMBERTON
NC13786.DAT NC ELIZABETH CITY
NC13881.DAT NC CHARLOTTE
NC93727.DAT NC JACKSONVILLE
NC93729.DAT NC CAPE HATTERAS
NC93737.DAT NC FT. BRAGG
NC93807.DAT NC WINSTON SALEM
ND14914.DAT ND FARGO
ND14916.DAT ND GRAND FORKS
ND14919.DAT ND JAMESTOWN
ND24011.DAT ND BISMARCK
ND24012.DAT ND DICKINSON/MUN.
ND24013.DAT ND MINOT
ND94014.DAT ND WILLISTON
NE14935.DAT NE GRAND_ISLAND
NE14939.DAT NE LINCOLN
NE14941.DAT NE NORFOLK
NE14942.DAT NE OMAHA
NE24017.DAT NE CHADRON
NE24023.DAT NE NORTH PLATTE
NE24028.DAT NE SCOTTSBLUFF
NE24030.DAT NE SIDNEY
NH04743.DAT NH PORTSMOUTH/PE
NH14710.DAT NH MANCHESTER/GR
NH14745.DAT NH CONCORD/MUN
NH14776.DAT NH WEST LEBANON

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NH94765.DAT NH LEBANON/REG
NJ14706.DAT NJ FORTDIX/MCGU
NJ14734.DAT NJ NEWARK/INT
NJ14780.DAT NJ LAKEHURST
NJ93730.DAT NJ ATLANTIC CITY
NJ94741.DAT NJ TETERBORO
NM23002.DAT NM ALAMOGORDO
NM23008.DAT NM CLOVIS
NM23039.DAT NM LAS CRUCES
NM23043.DAT NM ROSWELL
NM23048.DAT NM TUCUMCARI
NM23049.DAT NM SANTA FE
NM23050.DAT NM ALBUQUERQUE
NM23052.DAT NM RATON/CREWS
NM23054.DAT NM LAS VEGAS
NM23056.DAT NM OTTO
NM23058.DAT NM COLUMBUS
NM23081.DAT NM GALLUP
NM23090.DAT NM FARMINGTON
NM93033.DAT NM CARLSBAD
NM93034.DAT NM HOBBS
NM93044.DAT NM ZUNI
NM93045.DAT NM TRUTH OR CON.
NV03133.DAT NV YUCCA FLATS
NV23153.DAT NV TONAPAH
NV23154.DAT NV ELY
NV23169.DAT NV LAS VEGAS
NV23185.DAT NV RENO
NV24119.DAT NV BATTLE MOUNT.
NV24121.DAT NV ELKO
NV24128.DAT NV WINNEMUCCA
NV24172.DAT NV LOVELOCK
NV93102.DAT NV FALLON
NY04724.DAT NY NIAGARA FALLS
NY04725.DAT NY BINGHAMTON/BR
NY04742.DAT NY PLATTSBURGH
NY14714.DAT NY NEWBURGH/STEW
NY14717.DAT NY ROME/GRIFFIS
NY14719.DAT NY WESTHAMPTON B
NY14732.DAT NY NY/LAGUARDIA
NY14733.DAT NY BUFFALO/INT
NY14735.DAT NY ALBANY/CNTY
NY14747.DAT NY DUNKIRK
NY14748.DAT NY ELMIRA/CHEMUN
NY14750.DAT NY GLENSFALLS/W
NY14757.DAT NY POUGHKEEPSKIE
NY14768.DAT NY ROCHESTER/ROC
NY14771.DAT NY SYRACUSE/HANC
NY94704.DAT NY DANSVILLE MUN
NY94725.DAT NY MASSENA/RICHA
NY94745.DAT NY WHITE PLAINS
NY94790.DAT NY WATERTOWN/INT
OH13840.DAT OH DAYTON/WRIGHT
OH14820.DAT OH CLEVELAND
OH14821.DAT OH COLUMBUS
OH14825.DAT OH FINDLAY
OH14849.DAT OH TOLEDO
OH14852.DAT OH YOUNGSTOWN
OH14891.DAT OH MANSFIELD
OH14895.DAT OH AKRON/CANTON
OH93824.DAT OH ZANESVILLE
OK03932.DAT OK CLINTON

OK13902.DAT OK ALTUS
OK13909.DAT OK ENID
OK13945.DAT OK FT. SILL
OK13965.DAT OK ARDMORE
OK13967.DAT OK OKLAHOMA CITY
OK13968.DAT OK TULSA
OK13969.DAT OK PONCA CITY
OK13975.DAT OK GAGE
OK93986.DAT OK HOBART
OR24130.DAT OR BAKER
OR24148.DAT OR LA GRANDE
OR24152.DAT OR MEACHAM
OR24155.DAT OR PENDLETON
OR24221.DAT OR EUGENE
OR24225.DAT OR MEDFORD
OR24229.DAT OR PORTLAND
OR24230.DAT OR REDMOND
OR24231.DAT OR ROSEBURG
OR24232.DAT OR SALEM
OR24235.DAT OR SEXTON SUMMIT
OR24284.DAT OR NORTH BEND
OR94224.DAT OR ASTORIA
OR94236.DAT OR KLAMATH FALLS
PA04751.DAT PA BRADFORD/REG
PA13739.DAT PA PHILADELPH/INT
PA14736.DAT PA ALTOONA/BLAIR
PA14737.DAT PA ALLENTOWN/BET
PA14741.DAT PA BROOKVILLE
PA14751.DAT PA HARRISBURG
PA14760.DAT PA PARK PLACE
PA14761.DAT PA PHILIPSBURG
PA14770.DAT PA SELINGSGROVE
PA14777.DAT PA WILKESBARRE/S
PA14778.DAT PA WILLIAMSPORT
PA14793.DAT PA WILLOW GROVE
PA14860.DAT PA ERIE
PA94823.DAT PA PITTSBURGH/GR
RI14765.DAT RI PROVIDENCE/TF
RI14788.DAT RI QUONSET PT
SC03858.DAT SC EASTOVER
SC13717.DAT SC MYRTLE BEACH
SC13744.DAT SC FLORENCE
SC13849.DAT SC SUMTER
SC13880.DAT SC CHARLESTON
SC13883.DAT SC COLUMBIA
SC13886.DAT SC GREENVILLE
SC93804.DAT SC SPARTANBURG
SC93831.DAT SC BEAUFORT
SC93846.DAT SC ANDERSON
SD14929.DAT SD ABERDEEN
SD14936.DAT SD HURON
SD14944.DAT SD SIOUX FALLS
SD14946.DAT SD WATERTOWN
SD24024.DAT SD PHILIP
SD24025.DAT SD PIERRE
SD24090.DAT SD RAPID CITY
TN03809.DAT TN DYERSBERG
TN03811.DAT TN JACKSON
TN13827.DAT TN SMYRNA/SEWART
TN13877.DAT TN BRISTOL
TN13882.DAT TN CHATTANOOGA
TN13891.DAT TN KNOXVILLE/MUN.

APPENDIX D-5

TN13893.DAT TN MEMPHIS/INT.
TN13897.DAT TN NASHVILLE
TX03902.DAT TX FT.HOOD
TX12909.DAT TX SAN_ANTONIO
TX12910.DAT TX SAN_MARCOS
TX12912.DAT TX VICTORIA
TX12917.DAT TX PORT_ARTHUR
TX12918.DAT TX HOUSTON/HOBBY
TX12919.DAT TX BROWNSVILLE
TX12920.DAT TX LAREDO
TX12921.DAT TX SAN_ANTONIO
TX12923.DAT TX GALVESTON
TX12924.DAT TX CORPUS_CHRISTI
TX12925.DAT TX BEEVILLE
TX12928.DAT TX KINGSVILLE
TX12932.DAT TX ALICE
TX12935.DAT TX PALACIOS
TX12947.DAT TX COTULLA
TX12957.DAT TX PORT_ISABELL
TX13905.DAT TX BRYAN
TX13911.DAT TX FT.WORTH
TX13923.DAT TX SHERMAN
TX13958.DAT TX AUSTIN
TX13959.DAT TX WACO
TX13960.DAT TX DALLAS/LOVE
TX13962.DAT TX ABILENE
TX13966.DAT TX WICHITA_FALLS
TX13972.DAT TX TYLER
TX13973.DAT TX JUNCTION
TX22010.DAT TX DEL_RIO
TX23005.DAT TX BIG_SPRING
TX23019.DAT TX EL_PASO/BIGGS
TX23023.DAT TX MIDLAND
TX23034.DAT TX SAN_ANGELO
TX23040.DAT TX WINK
TX23042.DAT TX LUBBOCK
TX23047.DAT TX AMARILLO
TX93035.DAT TX MARFA
TX93042.DAT TX DALHART
TX93985.DAT TX MINERAL_WELLS
TX93987.DAT TX LUFKIN
UT23159.DAT UT BRYCE CANYON
UT23162.DAT UT DELTA
UT23170.DAT UT HANKSVILLE
UT23176.DAT UT MILFORD
UT24101.DAT UT OGDEN/HILL
UT24103.DAT UT DUGWAY PG
UT24127.DAT UT SALT LAKE/INT.
UT24193.DAT UT WENDOVER
UT93129.DAT UT CEDAR CITY
UT93198.DAT UT ST. GEORGE
VA13702.DAT VA HAMPTON
VA13726.DAT VA BLACKSTONE
VA13728.DAT VA DANVILLE
VA13731.DAT VA FRONTROYAL
VA13732.DAT VA GORDONSVILLE
VA13733.DAT VA LYNCHBURG
VA13740.DAT VA RICHMOND
VA13741.DAT VA ROANOKE
VA13743.DAT VA WASH/NATIONAL
VA13750.DAT VA NORFOLK
VA13755.DAT VA CHINCOTEAGUE

VA13760.DAT VA DAHLGREN
VA13769.DAT VA OCEANA
VA13773.DAT VA QUANTICO
VA13868.DAT VA PULASKI
VA93728.DAT VA DAVISON
VA93735.DAT VA FT. EUSTIS
VT14742.DAT VT BURLINGTON/IN
VT94705.DAT VT MONTPELIER/ED
WA24110.DAT WA MOSES LAKE
WA24141.DAT WA EPHRATA
WA24157.DAT WA SPOKANE
WA24160.DAT WA WALLA WALLA
WA24201.DAT WA FORT LEWIS
WA24203.DAT WA EVERETT
WA24217.DAT WA BELLINGHAM
WA24219.DAT WA DALLESFORT
WA24227.DAT WA OLYMPIA
WA24233.DAT WA SEATTLE
WA24237.DAT WA STAMPEDE PASS
WA24240.DAT WA TATOOSH IS.
WA24241.DAT WA TOLEDO
WA24243.DAT WA YAKIMA
WA24255.DAT WA WHIDBEY IS.
WA94225.DAT WA HOQUIAM
WA94240.DAT WA QUILLAYUTE
WI14837.DAT WI MADISON
WI14839.DAT WI MILWAUKEE
WI14897.DAT WI WAUSAU
WI14898.DAT WI GREEN BAY
WI14920.DAT WI LA CROSSE
WI14991.DAT WI EAU CLAIRE
WI14995.DAT WI GRANTSBURG
WI94930.DAT WI CAMP DOUGLAS
WV03860.DAT WV HUNTINGTON/TS.
WV03872.DAT WV BECKLEY
WV13729.DAT WV ELKINS
WV13734.DAT WV MARTINSBURG
WV13736.DAT WV MORGANTOWN
WV13738.DAT WV PETERSBURG
WV13866.DAT WV CHARLESTON
WV13867.DAT WV PARKERSBURG
WY24018.DAT WY CHEYENNE
WY24019.DAT WY DOUGLAS
WY24021.DAT WY LANDER
WY24022.DAT WY LARAMIE
WY24027.DAT WY ROCK SPRINGS
WY24029.DAT WY SHERIDAN
WY24057.DAT WY RAWLINS
WY24089.DAT WY CASPER
WY24118.DAT WY FORT BRIDGER

TO EXTRACT SOILS DATA FROM A SOIL INTERPRETATIONS RECORD

To estimate soil erosion by wind requires accurate input of basic soils data. The major source of this information is the SOIL INTERPRETATIONS RECORD (Soils Five) for the specific soil series. Some of the older Soils Five forms may not have all values listed. Current survey sheets should be used whenever available. When not available, a "best estimate" may be used or consult the NRCS Area Soil Scientist.

An example of the "Soils Five" sheet for the Amarillo Series is on the next page (APPENDIX E-2). From this sheet the following data are needed:

Sand %	Organic matter %
Silt %	Calcium carbonate (CaCO ₃) %
Clay %	

For wind erosion estimates, only the surface layer values are used. In this example the surface layer is 0-11 inches. For the Amarillo series the clay % varies from 10 to 18 %. See yellow block on next page. For illustration purposes, the average of 14 % is used. For other situations, use a number in the range that describes a particular soil.

The silt fraction is calculated from the following equation.

$$Silt \% = \left(\frac{Pass\ 200}{Pass\ 10} \times 100 \right) - Clay \% \quad [1]$$

In equation [1] "Pass 200" is the "percent of material less than 3" passing sieve no. 200". The range in our example is 30 to 55. See the green block on the next page. Use the average value of 43 %. "Pass 10" is the "percent of material less than 3" passing sieve no. 10". The value for our example is 100. See grey block on the next page. Again, averages may be used for silt or clay or any value in the range for a particular soil.

Solving equation [1] for silt gives the following.

$$Silt \% = \left(\frac{43}{100} \times 100 \right) - 14 \\ = 43 - 14 = 29$$

Sand % is calculated from the following equation.

$$Sand \% = 100 - Clay \% - Silt \% \quad [2]$$

The Amarillo series example is calculated below.

$$Sand \% = 100 - 14 - 29 = 57 \%$$

The organic matter is 0.5 to 1 %. See blue block. The CaCO₃ has no value on this form, but as these forms are updated and populated CaCO₃ values will be listed. See red block.

APPENDIX E-2

TX0130

SOIL INTERPRETATIONS RECORD

MLRA(S): 77, 78

AMARILLO SERIES

REV. JCW, 9-82

ARIDIC PALESTALFS, FINE-LOAMY, MIXED, THERMIC

THE AMARILLO SERIES CONSISTS OF DEEP, WELL DRAINED, NEARLY LEVEL TO GENTLY SLOPING SOILS OF UPLANDS. THE SOIL FORMED IN LOAMY, CALCAREOUS, ALLUVIAL OR EOLIAN MATERIALS. IN A REPRESENTATIVE PROFILE, THE SURFACE LAYER IS BROWN FINE SANDY LOAM ABOUT 11 INCHES THICK. THE SUBSOIL IS SANDY CLAY LOAM TO DEPTHS OF MORE THAN 99 INCHES. IT IS REDDISH BROWN IN THE UPPER 16 INCHES, YELLOWISH RED IN THE NEXT 11 INCHES, PINK WITH 60 PERCENT CALCIUM CARBONATE IN THE NEXT 29 INCHES, AND LIGHT REDDISH BROWN BELOW 85 INCHES. SLOPES RANGE FROM 0 TO 5 PERCENT.

LANDSCAPE AND CLIMATE PROPERTIES					
ANNUAL AIR TEMPERATURE	FROST FREE DAYS	ANNUAL PRECIPITATION	ELEVATION (FT)	DRAINAGE CLASS	SLOPE (PCT)
				W	0-5

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT. >10 IN (PCT)	FRACT. 3-10 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO.				CLAY (PCT)
						4	10	40	200	
0-11	FSL	SM, SM-SC, CL-ML, ML	A-2-4, A-4	0	0	100	100	95-100	30-55	10-18
0-11	LFS	SM, SM-SC	A-2-4	0	0	100	100	95-100	15-35	5-15
11-38	SCL, CL	SC, SM-SC, CL	A-4, A-6	0	0	100	100	95-100	35-65	20-35
38-40	SCL, CL	SC, CL, SM-SC	A-4, A-6	0	0	90-100	90-100	65-98	35-70	20-35

DEPTH (IN.)	LIQUID LIMIT	PLASTICITY INDEX	MOIST BULK DENSITY (G/CM ³)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SAR	CEC	CACO ₃ (PCT)	GYPSUM (PCT)
0-11	17-25	3-7	1.35-1.60	2.0-6.0	0.11-0.15	6.6-7.8	-				
0-11	<22	NP-4	1.40-1.60	2.0-6.0	0.06-0.10	6.6-7.8	-				
11-38	20-40	7-20	1.30-1.65	0.6-2.0	0.14-0.18	7.4-8.4	-				
38-80	20-35	7-17	1.40-1.80	0.6-2.0	0.10-0.15	7.9-8.4	-				

DEPTH (IN.)	ORGANIC MATTER (PCT)	SHRINK-SWELL POTENTIAL	EROSION FACTORS		WIND EROD. GROUP	WIND EROD. INDEX	CORROSIVITY	
			K	T			STEEL	CONCRETE
0-11	.5-1	LOW	.24	5	3	86	MODERATE	LOW
0-11	.5-1	VERY LOW	.15	5	2	134		
11-38		LOW	.32					
38-80		LOW	.32					

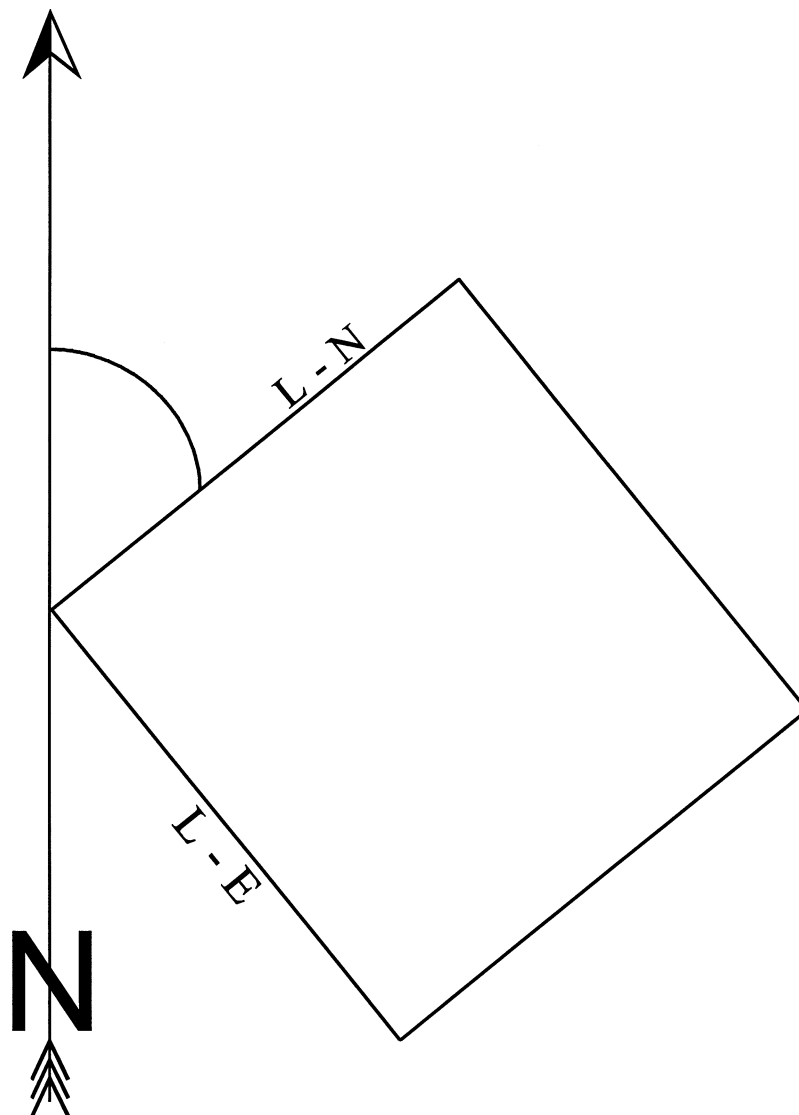
FLOODING			HIGH WATER TABLE			CEMENTED PAN		BEDROCK		SUBSIDENCE		HYD	POTENTIAL
			DEPTH (FT)	KIND	MONTHS	DEPTH (IN)	HARDNESS	DEPTH (IN)	HARDNESS	INIT. (IN)	TOTAL (IN)	GRP	FROST ACTION
FREQUENCY	DURATION	MONTHS											
NONE			>6.0			-		>60		-		8	-

APPENDIX E-3

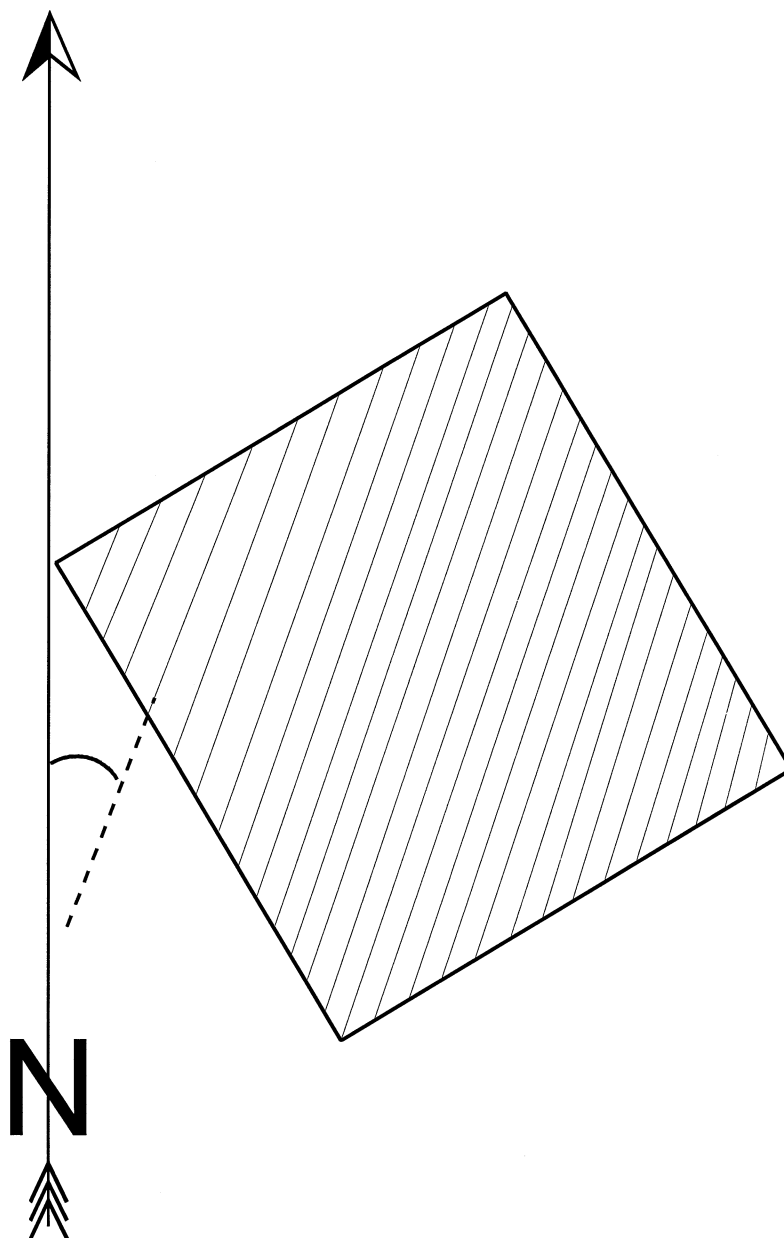
Soils Input Data						
Texture	Filename ¹	Sand %	Silt %	OM %	CaCO ₃ %	Rock Cover %
Sand	SAND	93	4	0.3	1	0
Loamy Sand	LOAMY_SA	84	10	0.5	2	0
Sandy Loam	SANDY_LO	64	26	0.5	3	0
Sandy Clay Loam	SANDY_CL	59	13	1.0	3	0
Sandy Clay	SANDY_C	52	7	1.0	3	0
Silt	SILT	6	88	1.5	3	0
Silt Loam	SILT_LOA	21	67	1.5	3	0
Loam	LOAM	41	41	1.5	3	0
Silty Clay Loam	SILTY_CL	10	56	2.0	3	0
Silty Clay	SILTY_C	6	47	2.5	3	0
Clay Loam	CLAY_LOA	32	34	2.5	3	0
Clay	CLAY	20	20	3.0	3	0

¹ Use this filename to access the file in sub-directory RWEQ97.

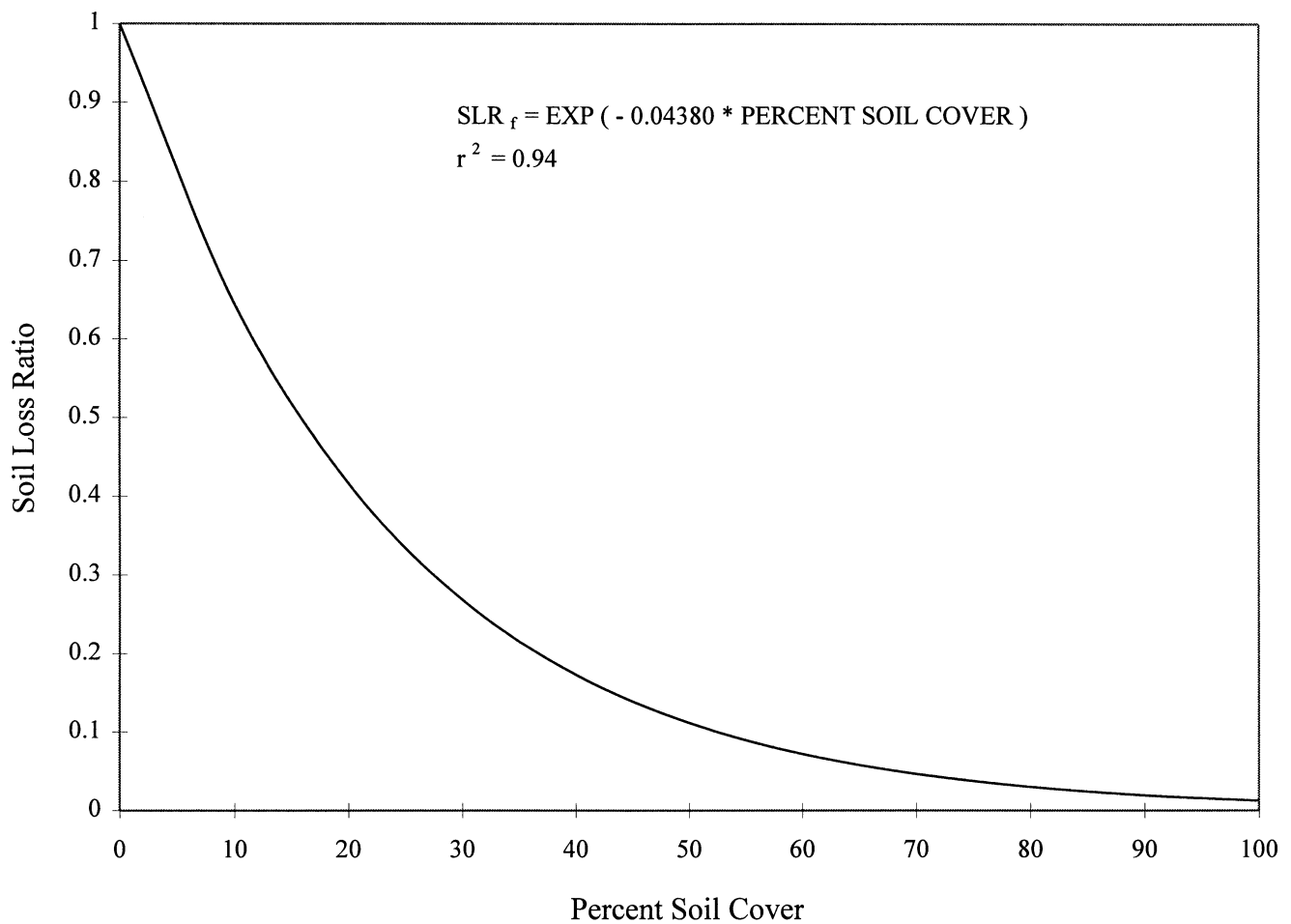
APPENDIX F-1



Indicate field orientation by starting from the west corner. The angle from north is expressed in degrees clockwise.



Indicate field row (ridge-furrow) orientation. The angle from north is expressed in degrees clockwise.



Relationship between percent of soil surface covered with nonerodible materials and soil loss ratio (SLRf=soil loss from partial cover divided by soil loss from bare soil).

HOW-TO

The conservation tillage (no-till, mulch-till, ridge-till) goal:

Leave 30 percent or more crop residue after planting.

Please feel free to reprint any portion of *Conservation Impact*. Contact CTIC on availability of additional copies.

Measuring crop residue: Line-transect method

Here's a step by step procedure for using the line-transect method to measure the percentage of crop residue protecting your soil.

Step one: Select an area in the field that is representative of the whole field. Avoid end rows, areas affected by flooding, drought, weed or insect infestations.

Step two: Lay out a 100- or 50-foot line diagonally to the direction of the rows in the field. This will give you a more accurate residue reading than following the rows. The tape or line you use should be clearly marked at regular intervals.

Step three: Anchor both ends of the line.

Step four: Walk along the line or tape and look straight down at each recording point. Count the number of points that are directly over a piece of residue. As you record numbers, remember to

- look straight down,
- always count from the same side of the line,
- avoid moving the tape while counting.

There will be some judgment calls. To help decide if the residue intersects the mark, remember that a piece of residue must be large enough to dissipate the energy of a raindrop during an intense storm. To be counted, the residue must be larger in diameter than this dot ●. Use a 3/32-inch diameter wooden dowel rod or brazing rod from a farm supply or hardware store to represent such a dot when you're in the field. Don't count the residue if it's too small or fails to intersect the mark.

Looking straight down at the ground...

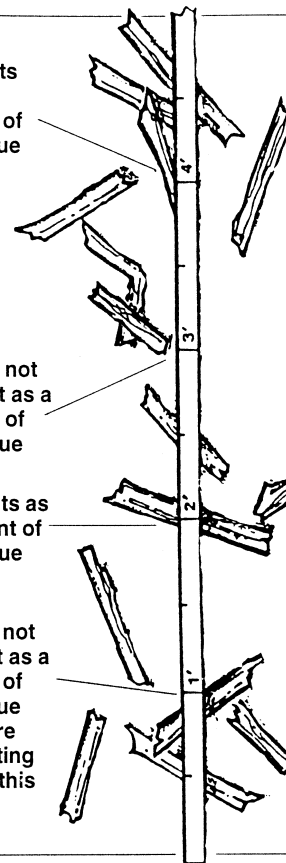
Using only one side of the measuring tape, (for this illustration, we used the left side of the tape) check each one-foot mark. Count only if the residue is directly under each mark (in a real-field situation the residue should also be larger than this dot ● to be counted. Use a 3/32-inch wooden dowel rod to represent the dot when counting residue in the field).

Counts as a point of residue

Does not count as a point of residue

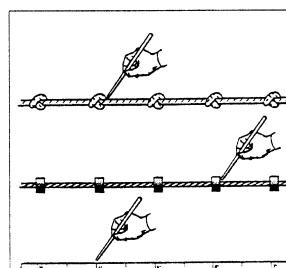
Counts as a point of residue

Does not count as a point of residue (you're counting from this side)



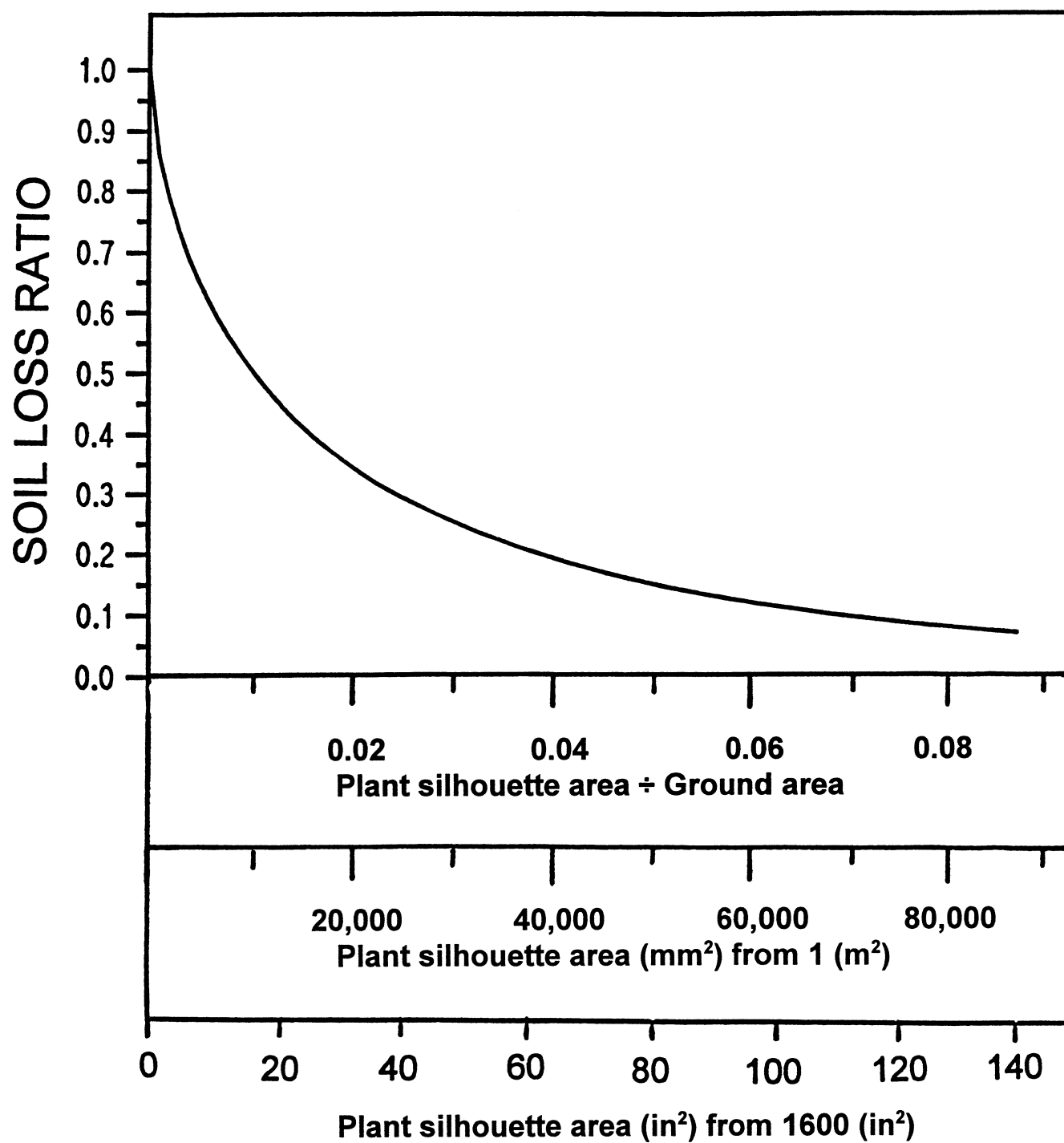
Step Five: The total number of intersections you found equals the percentage of ground surface covered by residue. If 44 out of 100 points intersect residue, then you have 44 percent residue coverage in this area of the field. On a 50-foot tape the number of marks that intersect residue must be multiplied by 2.

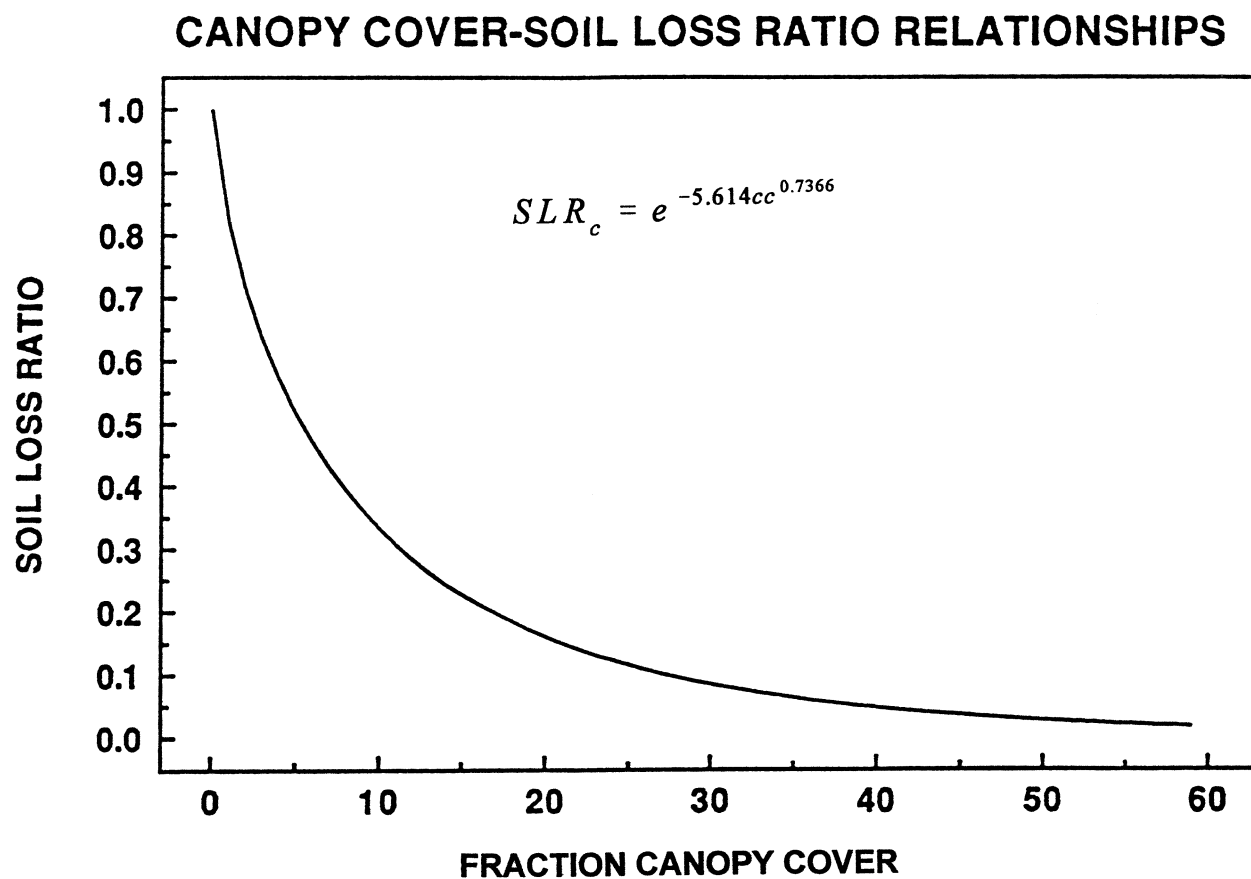
Step six: Repeat the procedure at three to five random locations in the field and average the results to arrive at an estimate of residue cover for the entire field.



You can use various types of measuring devices, but be sure you measure at the same point at each interval.

To help you determine ways to increase your crop residue levels, order a *Crop Residue Scorecard* from CTIC. Developed by the Equipment Manufacturers Institute and NRCS, the scorecard offers a formula which will help you estimate how implements, climatic conditions, and the type of residue your crop produces impact your crop residue levels. Just 25 cents a copy (four copy minimum order), 30 or more copies for 10 cents each. **Contact:** Conservation Technology Information Center at (317) 494-9555.





Relationship between percent of the soil surface covered with growing crop canopy and soil loss ratio.

APPENDIX G-4

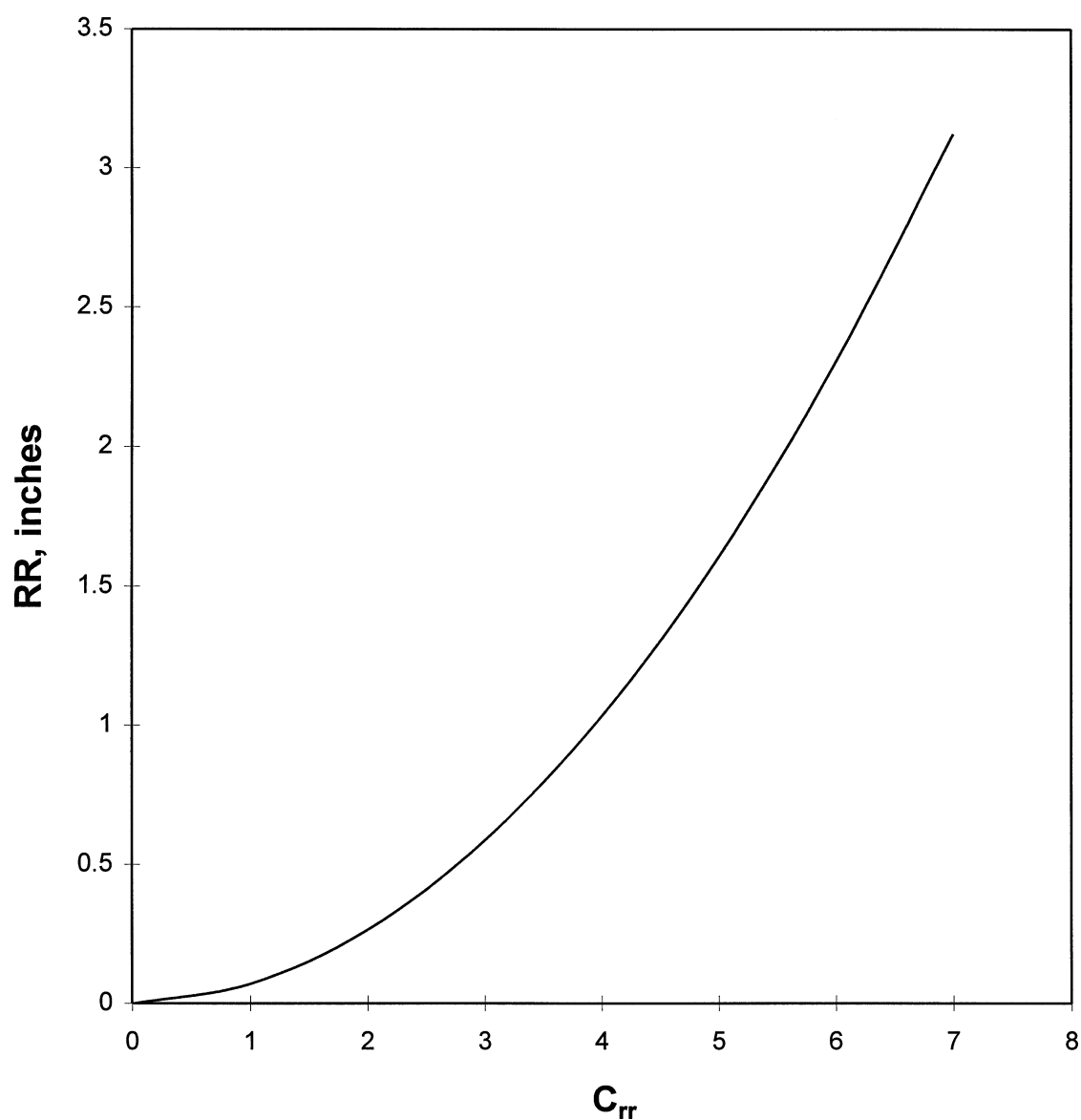
Typical values of canopy cover for row crops and small grain crops from Table 5.1 in RUSLE Version 1.01

Fraction of land surface covered by canopy						
No. of days after planting	Corn	Soybeans	Cotton	Sorghum	Winter small grain ¹	Spring small grain
15	0.0	0.0	0.0	0.0	0.0	0.0
30	0.1	0.1	0.1	0.1	0.1	0.1
45	0.5	0.3	0.3	0.5	0.3	0.4
60	0.8	0.7	0.7	0.8	0.4	0.9
75	1.0	1.0	1.0	1.0	0.4	1.0
90	1.0	1.0	1.0	1.0	0.4	1.0
105	1.0	0.9	0.9	1.0	0.4	1.0
120	1.0	0.5	0.5	1.0	0.4	1.0
135	1.0	0.5	0.5	1.0	0.4	1.0
150	1.0	0.5	0.5	1.0	0.5	1.0
165	1.0	0.5	0.5	1.0	0.7	1.0
180	1.0	0.5	0.5	1.0	0.9	1.0
195	1.0	0.5	0.5	1.0	1.0	1.0
210	1.0	0.5	0.5	1.0	1.0	1.0

¹ These are specific areas with a spring and summer precipitation regime, and are not typical for the Northwestern Wheat and Range Region.

Chain Reading (C_{rr}) and Random Roughness Element

$$RR = 0.00734(C_{rr}) + 0.0627(C_{rr})^2$$
$$r^2 = 0.963$$



K' as Function of Chain Random Roughness (C_{rr}) and Oriented Roughness (K_r)

L_2^+	40	39.6	39.2	38.8	38.4	38.0	37.6	37.2	36.8	36.4	36.0	35.6	35.2	34.8	34.4	34.0	33.6	33.2	32.8		
	C_{rr}^*	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
K_r^{**}	----- K' -----																				
	inch																				
	cm																				
	0	0	1.00	0.88	0.78	0.69	0.61	0.54	0.48	0.42	0.37	0.33	0.29	0.26	0.23	0.20	0.18	0.16	0.14	0.12	0.11
	1	2.5	0.36	0.31	0.28	0.25	0.22	0.19	0.17	0.15	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04
	2	5.1	0.21	0.19	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02
	3	7.6	0.15	0.13	0.12	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02
	4	10.2	0.12	0.11	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01
	5	12.7	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
	6	15.2	0.10	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	7	17.8	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	8	20.3	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	9	22.9	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
10	25.4	0.11	0.10	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	
11	27.9	0.12	0.11	0.10	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01	
12	30.5	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	

* Chain random roughness value (C_{rr}) computed as $C_{rr} = \left(1 - \frac{L_2}{L_1}\right) \times 100$ where L₁ = any chain length and L₂ = horizontal length over the rough surface (Saleh, 1993).

** $K_r = 4 \times \frac{(\text{ridge height})^2}{\text{ridge spacing}}$ (See table in Appendix H-3.)

† L₂ measurement in inches when L₁ (chain length) is 40 inches.

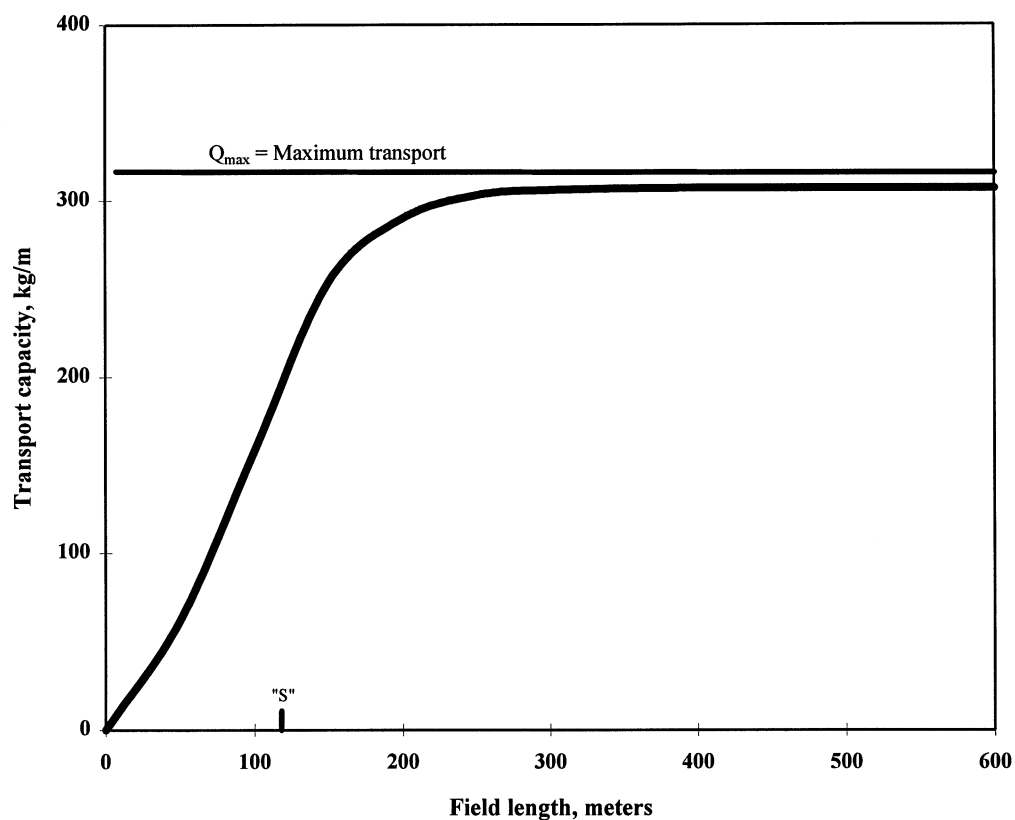
‡ **EXAMPLES:** If L₂ (using the 40" chain laid *parallel* to the ridges and furrows) is 36" and K_r = 0, then K' = 0.29.
If ridges are 4" high with 16" spacing, then the K_r (left hand column) is 4. With no *random* roughness (L₂ = 40 or C_{rr} = 0) the K' = 0.12.
With the combination of random roughness (L₂ = 36") and ridge roughness (K_r = 4) the K' = 0.03. (See the bolded values.)

APPENDIX H-3

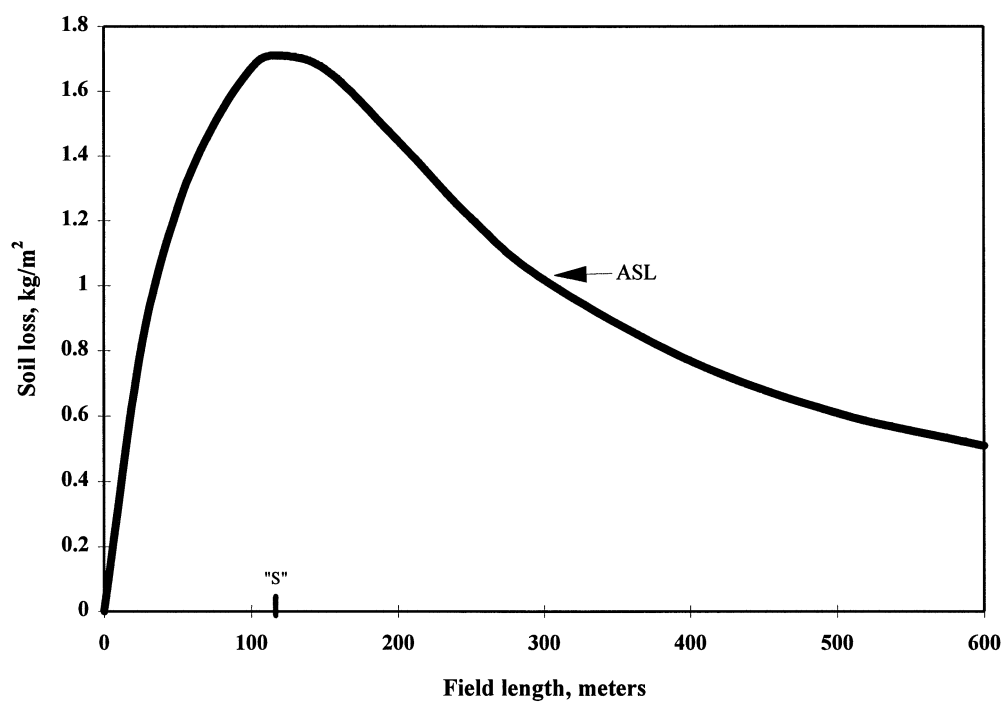
Table to determine soil ridge roughness (K_r) when ridge height and ridge spacing are known.

Ridge Spacing, inches	Ridge Height, inches									
	1	2	3	4	5	6	7	8	9	10
	----- K_r -----									
2	2	8	-	-	-	-	-	-	-	-
4	1	4	9	-	-	-	-	-	-	-
6	1.5	2.7	6	10.7	-	-	-	-	-	-
8	0.5	2	4.5	8.0	-	-	-	-	-	-
10	0.4	1.6	3.6	6.4	10.0	-	-	-	-	-
12	0.3	1.3	3.0	5.3	8.2	11.9	-	-	-	-
14	0.3	1.1	2.6	4.6	7.1	10.3	-	-	-	-
16	0.2	1.0	2.2	4.0	6.2	9.0	-	-	-	-
18	0.2	1.0	2.0	3.6	5.6	8.0	10.9	-	-	-
20	0.2	0.8	1.8	3.2	5.0	7.2	9.8	-	-	-
24	0.2	0.6	1.5	2.7	4.2	6.0	8.2	10.7	-	-
28	0.1	0.6	1.3	2.3	3.6	5.1	7.0	9.1	-	-
32	0.1	0.5	1.1	2.0	3.1	4.5	6.1	8.0	10.1	-
36	0.1	0.4	1.0	1.8	2.8	4.0	5.4	7.1	9.0	-
40	0.1	0.4	0.9	1.6	2.5	3.6	4.9	6.4	8.1	10.0
45	0.1	0.4	0.8	1.4	2.2	3.2	4.4	5.7	7.2	8.8
50	0.1	0.3	0.7	1.3	2.0	2.9	3.9	5.1	6.5	8.0
55	0.1	0.3	0.7	1.2	1.8	2.6	3.6	4.7	5.9	7.2
60	0.1	0.3	0.6	1.1	1.7	2.4	3.3	4.3	5.4	6.6
70	0.1	0.2	0.5	0.9	1.4	2.1	2.8	3.7	4.6	5.7
80	0.1	0.2	0.5	0.8	1.2	1.8	2.4	3.2	4.0	5.0
90	0.0	0.2	0.4	0.7	1.1	1.6	2.2	2.8	3.6	4.4
100	0.0	0.2	0.4	0.6	1.0	1.4	2.0	2.6	3.2	4.0
110	0.0	0.1	0.3	0.6	0.9	1.3	1.8	2.3	2.9	3.6
120	0.0	0.1	0.3	0.5	0.8	1.2	1.6	2.1	2.7	3.3

For example: If ridge height is 8" and spacing is 36" the K_r is 7.1; however, if the wind is at an angle such that the 8" ridges are spaced 90" along the path of the wind, the K_r is 2.8".



Relationship between quantity of soil being transported by the wind and length of the field. The Q_{\max} is the calculated maximum transport capacity of wind over that specific soil surface. The "S" is the Field length where 63% of the winds transport capacity has been utilized.



Relationship between soil loss and field length. The maximum soil loss (MSL) per unit area occur at length "S". This point is designated MSL and characterizes maximum loss for any field longer than "S". The average soil loss (ASL) is the transport mass divided by field length.

APPENDIX J-1

Summary of Direction, Maximum Transport Capacity (Q_{\max}), Distance (S) where wind has 63.2% of total capacity, and Average Soil Loss for each erosion event in Big Spring, Texas - 1990

Date	Dir	Q_{\max} <i>kg/m</i>	S <i>meters</i>	Average Soil Loss <i>kg/m²</i>
01-10-90	240	108.7	309	.154
01-22-90	210	63.8	279	.107
01-24-90	345	378.7	108	2.052
01-26-90	183	99.1	32	.684
01-28-90	44	112.2	123	.553
01-29-90	203	133.2	88	.802
02-05-90	176	233.1	59	1.541
02-08-90	180	96.2	289	.152
02-12-90	191	58.7	31	.406
02-15-90	262	300.6	34	2.070
02-22-90	338	255.8	31	1.769
02-24-90	184	93.6	41	.639
02-26-90	169	6.0	62	.039
03-04-90	186	59.9	107	.326
03-05-90	175	49.9	81	.309
03-06-90	246	226.2	149	.930
03-07-90	219	8.8	31	.061
03-11-90	235	90.3	92	.533
03-12-90	157	110.3	33	.761
03-13-90	333	96.1	32	.664
03-14-90	264	540.0	139	2.388
03-18-90	25	235.2	36	1.616
03-21-90	179	12.0	47	.081
04-05-90	23	477.9	169	1.697
04-23-90	244	25.3	31	.175
04-27-90	330	2.7	31	.018
05-07-90	220	18.9	91	.112
05-08-90	200	0.2	31	.002
05-09-90	25	56.4	291	.088
05-13-90	208	2.4	78	.015
05-15-90	170	89.4	289	.142
05-20-90	267	7.5	35	.051
06-01-90	206	3.8	31	.027
Total				20.964

APPENDIX J-2

USDA-ARS, BIG SPRING, TEXAS SUMMARY OF BIG SPRING, TEXAS DATA LOGGER

January, 1990

WEIBULL WIND COEFFICIENTS: c=5.68 k=2.11 % calm=5.00

MON	DAY	MAX TEMP C	MIN TEMP C	-----WIND----- MAX m/sec	MIN m/sec	FACTOR (WS-5) ² (WS)	AVG DIR deg	AVG RH %	TOTAL RAIN mm	EI *	SOLAR RAD cal/cm ²
1	.	24	-6	13.1	3.8	409434	193	42	27.4	71.66	7949
1	5	11	1	5.8	2.0	7	114	41	.	.	5
1	6	10	-6	6.7	2.9	222	188	39	.	.	272
1	7	17	-6	6.1	2.9	83	258	37	.	.	339
1	8	21	-3	9.1	3.9	10726	240	23	.	.	338
1	9	19	1	8.8	2.7	2518	143	24	.	.	329
1	10	24	1	7.5	3.1	1390	247	26	.	.	341
1	11	20	0	8.2	4.2	5722	137	25	.	.	348
1	12	11	-2	6.6	3.3	381	56	22	.	.	342
1	13	16	-1	8.5	4.0	10165	158	20	.	.	321
1	14	24	-1	7.9	4.2	2029	215	30	.	.	346
1	15	24	7	9.0	4.8	8740	190	66	.	.	317
1	16	23	11	10.7	5.2	24677	193	61	.	.	278
1	17	21	3	4.6	2.0	.	173	53	0.8	0.07	354
1	18	11	2	11.9	7.3	138274	54	79	19.8	58.85	30
1	19	9	1	7.9	3.8	2153	269	85	6.9	12.74	252
1	20	13	-1	5.0	2.1	0	231	74	.	.	360
1	21	15	-2	5.8	2.3	20	239	66	.	.	360
1	22	20	0	8.2	3.4	2362	236	56	.	.	318
1	23	18	9	4.9	2.8	.	235	56	.	.	113
1	24	18	1	13.1	5.1	79810	286	56	.	.	312
1	25	14	-6	6.8	2.6	128	251	42	.	.	380
1	26	22	2	11.0	6.1	43326	205	18	.	.	380
1	27	13	3	10.1	5.1	31972	107	24	.	.	261
1	28	11	-2	7.5	3.9	1863	183	31	.	.	285
1	29	20	-6	10.8	4.9	40966	224	25	.	.	392
1	30	18	-2	6.4	3.1	111	156	20	.	.	396
1	31	20	8	7.6	3.4	1788	161	40	.	.	182

MONTHLY AVERAGES

Max. temp
17.1

Min. temp
0.5

Max. wind speed
8.0

Monthly averages are based on available data.

* The units of EI are megajoule-millimeter/hectare-hour.

. The first line in the table is a summary of the entire table.

APPENDIX J-3

USDA-ARS, BIG SPRING, TEXAS SUMMARY OF BIG SPRING, TEXAS DATA LOGGER

February, 1990

WEIBULL WIND COEFFICIENTS: c=6.07 k=2.30 % calm=5.16

MON	DAY	TEMP		-----WIND-----			AVG DIR deg	AVG RH %	TOTAL RAIN mm	EI *	SOLAR RAD cal/cm ²
		MAX C	MIN C	MAX m/sec	MIN m/sec	FACTOR (WS-5) ² (WS)					
2	.	27	-5	12.9	4.0	421866	196	47	43.7	152.7	9758
2	1	21	9	7.4	2.7	650	213	63	0.8	0.07	287
2	2	21	2	8.1	2.3	618	231	53	.	.	376
2	3	13	1	9.7	3.9	11619	294	39	.	.	302
2	4	17	-4	7.0	2.9	479	202	35	.	.	416
2	5	20	5	12.5	5.7	77286	175	21	.	.	404
2	6	22	2	8.5	3.2	2998	244	21	.	.	416
2	7	24	2	9.1	3.8	4315	208	20	.	.	424
2	8	24	8	9.3	4.4	8080	229	56	.	.	290
#											
2	9	15	3	9.2	3.6	3628	208	68	0.8	0.07	116
2	10	20	-3	8.2	3.1	3925	237	53	.	.	419
2	11	23	-1	5.1	2.1	0	191	29	.	.	437
2	12	27	6	10.6	5.3	46687	207	17	.	.	385
2	13	25	13	8.4	4.7	3391	203	22	.	.	210
2	14	19	-1	7.7	5.0	3862	81	71	4.8	1.02	154
2	15	13	-1	12.9	4.9	70777	175	63	1.3	0.12	347
2	16	13	-5	6.3	2.8	114	215	27	.	.	458
2	17	17	-3	9.3	4.1	9643	125	24	.	.	446
2	18	21	2	5.2	2.2	0	183	35	.	.	442
2	19	16	1	8.9	3.9	11781	150	70	.	.	431
2	20	12	5	9.2	4.4	16266	146	91	24.9	132.9	94
2	21	14	0	8.2	4.4	4791	285	65	.	.	458
2	22	15	1	12.7	5.1	52322	302	55	.	.	356
2	23	20	-1	6.3	2.4	27	216	53	.	.	480
2	24	23	2	8.8	2.5	1672	197	40	.	.	484
2	25	25	8	10.6	6.3	38949	185	23	.	.	478
2	26	24	10	9.2	5.4	21369	173	46	.	.	450
2	27	16	8	10.4	3.9	6213	143	84	10.4	17.84	92
2	28	8	2	8.8	6.1	20404	77	89	0.8	0.64	107

MONTHLY AVERAGES

Max. temp
18.9

Min. temp
2.6

Max. wind speed
8.8

Monthly averages are based on available data.

* The units of EI are megajoule-millimeter/hectare-hour.

. The first line in the table is a summary of the entire table.

Data are missing from day 8, hour 1453 to day 9, hour 0956.

APPENDIX J-4

USDA-ARS, BIG SPRING, TEXAS SUMMARY OF BIG SPRING, TEXAS DATA LOGGER

March, 1990

WEIBULL WIND COEFFICIENTS: c=6.21 k=2.05 % calm=5.55

MON	DAY	MAX TEMP C	MIN TEMP C	-----WIND----- MAX m/sec	MIN m/sec	FACTOR (WS-5) ² (WS)	AVG DIR deg	AVG RH %	TOTAL RAIN mm	EI *	SOLAR RAD cal/cm ²
3	.	30	-3	15.7	4.2	655243	165	63	33.5	86.15	9892
3	1	5	0	7.5	3.5	1659	189	87	.	.	106
3	2	18	-3	4.0	1.7	.	186	71	.	.	481
3	3	18	2	5.9	2.1	16	187	51	.	.	442
3	4	25	9	8.8	4.3	8776	200	39	.	.	484
3	5	24	13	9.7	5.9	30134	172	70	.	.	300
3	6	22	12	10.6	5.2	35870	224	48	.	.	389
3	7	24	7	8.9	3.1	5455	252	18	.	.	533
3	8	29	7	8.2	2.9	2111	211	35	.	.	527
3	9	26	16	9.4	4.7	17882	160	75	.	.	370
3	10	23	14	12.1	4.3	19042	147	87	22.9	82.64	121
3	11	22	12	13.9	6.1	136342	211	52	2.8	1.95	519
3	12	29	14	11.3	6.0	36740	184	57	.	.	528
3	13	27	12	15.2	7.0	126781	192	58	1.0	0.28	317
3	14	12	3	15.7	5.9	138677	280	38	0.8	0.25	421
3	15	16	0	9.3	3.4	2225	235	52	.	.	426
#											
3	20	23	11	7.7	5.1	2817	182	20	.	.	527
3	21	29	9	10.8	5.7	21431	202	28	.	.	555
3	22	30	11	6.6	3.3	279	159	52	.	.	523
3	23	25	3	10.5	4.4	37541	89	73	.	.	520
3	24	3	-2	8.6	5.0	10468	39	93	0.5	0.02	96
†	3	25	1	-2	4.9	2.2	49	94	0.3	0.01	79
3	26	9	0	7.3	3.2	174	60	84	0.3	0.01	235
3	27	13	5	7.1	3.4	1007	180	90	3.3	0.69	120
3	28	27	9	8.2	5.0	8616	210	60	.	.	553
3	29	16	7	8.4	5.6	11066	53	90	0.8	0.12	172
3	30	16	7	6.3	2.8	129	93	82	1.0	0.16	277
3	31	20	7	5.4	2.8	5	149	81	.	.	270

MONTHLY AVERAGES

Max. temp
19.6

Min. temp
6.8

Max. wind speed
9.0

Monthly averages are based on available data.

* The units of EI are megajoule-millimeter/hectare-hour.

. The first line in the table is a summary of the entire table.

Data are missing from day 15, hour 1540 to day 20, hour 0905.

† The 2-meter anemometer was hung from day 25, hour 0512 to hour 1512.

APPENDIX J-5

USDA-ARS, BIG SPRING, TEXAS SUMMARY OF BIG SPRING, TEXAS DATA LOGGER

April, 1990

WEIBULL WIND COEFFICIENTS: c=5.90 k=2.00 % calm=3.42

MON DAY		MAX TEMP C	MIN TEMP C	-----WIND----- MAX m/sec	MIN m/sec	FACTOR (WS-5) ² (WS)	AVG DIR deg	AVG RH %	TOTAL RAIN mm	EI *	SOLAR RAD cal/cm ²
4	.	35	2	16.5	4.3	537518	131	60	64.5	176.6	12802
4	1	24	12	10.7	2.5	3291	125	81	4.6	2.14	339
4	2	20	10	9.4	4.9	18600	58	64	.	.	528
4	3	22	7	5.9	2.4	40	137	49	.	.	465
4	4	28	9	8.0	3.1	1105	241	46	.	.	604
4	5	30	6	14.1	5.9	139056	184	61	.	.	588
4	6	13	2	10.6	5.1	37782	40	51	.	.	465
4	7	20	4	7.3	3.7	985	131	36	.	.	581
4	8	24	10	8.9	4.7	10187	152	47	.	.	481
4	9	30	15	9.5	5.0	12460	206	46	.	.	542
4	10	21	10	8.9	4.5	8673	67	35	.	.	623
4	11	22	6	7.7	3.6	869	102	45	.	.	594
4	12	23	8	14.0	6.0	84223	141	51	7.1	7.24	583
4	13	29	13	11.6	3.4	6245	169	69	0.3	0.12	417
4	14	28	13	7.6	3.5	976	102	58	.	.	598
4	15	35	17	9.7	4.8	13271	173	49	.	.	631
4	16	35	16	10.7	4.9	20544	166	58	.	.	570
4	17	20	6	10.6	5.8	29571	77	84	.	.	119
4	18	10	5	12.1	3.9	6032	71	92	25.1	24.76	31
4	19	20	9	5.4	2.3	1	101	90	2.3	0.37	123
4	20	25	15	6.6	3.1	357	106	86	.	.	456
4	21	27	16	6.3	2.7	108	99	80	.	.	435
4	22	28	18	7.9	3.9	2597	153	66	.	.	443
4	23	30	11	16.5	4.7	25852	168	69	24.9	141.8	420
4	24	29	13	11.7	5.2	33357	150	63	0.3	0.11	595
4	25	26	15	16.2	5.4	60804	202	53	.	.	482
#											
4	29	34	15	9.3	4.6	4863	178	33	.	.	648
4	30	17	8	8.6	5.9	15666	53	54	.	.	441

MONTHLY AVERAGES

Max. temp
24.8

Min. temp
10.8

Max. wind speed
9.8

Monthly averages are based on available data.

* The units of EI are megajoule-millimeter/hectare-hour.

. The first line in the table is a summary of the entire table.

Data are missing from day 25, hour 1552 to day 29, hour 0143.

APPENDIX J-6

USDA-ARS, BIG SPRING, TEXAS SUMMARY OF BIG SPRING, TEXAS DATA LOGGER

May, 1990

WEIBULL WIND COEFFICIENTS: c=6.62 k=3.05 % calm=3.35

MON DAY	TEMP		-----WIND-----				AVG	AVG	TOTAL	EI	SOLAR
	MAX	MIN	MAX	MIN	FACTOR		DIR	RH	RAIN	*	RAD
	C	C	m/sec	m/sec	(WS-5) ² (WS)		deg	%	mm		cal/cm ²
5	.	42	6	11.2	4.5	401235	169	42	7.4	3.36	18037
5	1	12	8	9.7	6.0	18979	44	84	1.5	0.54	127
5	2	13	7	7.3	3.8	1707	117	90	3.3	0.90	154
5	3	20	6	8.5	3.4	4294	269	67	.	.	502
5	4	21	6	7.3	3.8	1389	199	51	.	.	631
5	5	23	7	7.0	2.4	422	79	44	.	.	615
5	6	26	7	8.4	2.0	102	177	35	.	.	675
5	7	27	14	9.4	5.6	19761	174	29	.	.	618
5	8	34	14	9.0	5.3	13279	210	43	.	.	673
5	9	26	13	9.3	5.0	15150	116	38	.	.	677
5	10	21	9	7.8	4.5	4276	92	32	.	.	399
5	11	33	14	10.1	4.3	8637	190	44	.	.	524
5	12	31	12	7.1	2.7	235	240	35	.	.	702
5	13	36	16	9.9	4.8	21978	147	21	.	.	654
5	14	38	21	10.4	5.2	28076	187	38	.	.	646
5	15	37	23	11.2	6.3	37835	193	44	.	.	577
5	16	33	19	9.7	4.4	16393	227	31	.	.	711
5	17	27	14	9.1	5.8	13349	87	48	.	.	429
5	18	31	20	10.7	6.9	71549	179	51	.	.	574
5	19	36	21	9.8	5.2	22312	233	35	.	.	694
5	20	34	18	10.6	5.1	33303	256	11	.	.	701
5	21	30	13	8.2	3.9	5857	93	36	.	.	681
5	22	32	15	6.1	3.2	71	88	41	.	.	683
5	23	36	19	8.9	4.8	10002	140	37	.	.	670
5	24	38	21	10.5	5.2	12202	208	45	.	.	586
5	25	42	23	9.9	4.5	8138	233	28	.	.	624
5	26	38	22	7.0	3.6	439	262	28	.	.	644
5	27	33	17	7.9	4.1	5235	148	27	.	.	693
5	28	28	18	7.8	4.8	3506	76	62	.	.	589
5	29	33	20	10.5	4.7	11897	153	60	2.5	1.92	304
5	30	35	13	7.4	2.9	354	246	32	.	.	715
5	31	36	20	10.8	4.5	10509	167	44	.	.	565

MONTHLY AVERAGES

Max. temp
30.3

Min. temp
15.2

Max. wind speed
8.9

Monthly averages are based on available data.

* The units of EI are megajoule-millimeter/hectare-hour.

. The first line in the table is a summary of the entire table.

CLIENT FILE: AC89

AC89.W1

24015 USA CO AKRON modified for Akron, CO JAN-MAY 1989 and NOV-DEC 1988

40 07 N 103 10 W 1399 19480101 19541231 ARF 60 64

[illegible]

40 6 N 103 9 W 2.3 CO AKRON CAA AP

RWEO INPUT FORM

CLIENT: AC 89

WEATHER FILE: AC89. W1

MANAGEMENT FILE: AC89, MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

- *shape
- *area
- *orientation
- *length_N
- *slope gradient
- *slope length

circular or rectangular
6.5 acres
 _____ degrees from north
 _____ feet
 _____ feet

EF: 0.42

SCF: 0.24

Longitude $103^{\circ} 9'$

Latitude $40^{\circ} 11'$

Elevation 4400' (1341m)

Annual Rainfall 16.4" (417mm)

[illegible]

Soil Loss = 29.90 t/ac

$\rho = 6.70 \text{ kg/m}^3$

Soil Loss = 1.7 t/ac
= .38 kg/m²

Soil Loss = 7.0 t/ac
= 1.57 kg/m²

Soil Loss = 3.6 t/ac
= .81 kg/m²

APPENDIX K-5

CLIENT FILE: CPI90

CPI90.W1

14834 USA IL JOLIET modified for Crown Point IN JAN-JUN 90 to DEC 90

41 30 N 88 10 W 181 19460101 19521231 ARW 150 101

6.83	7.12	6.10	5.27	5.41	4.96	4.04	2.74	3.67	5.07	6.34	5.85
1.89	2.52	2.36	2.48	1.92	1.83	2.38	1.50	1.79	1.96	2.36	2.29
1.29	1.29	1.26	1.23	1.20	1.18	1.17	1.18	1.20	1.22	1.25	1.28
225	247	203	203	203	203	225	225	203	203	203	225
1.9	1.7	1.8	1.6	2.0	2.5	3.5	2.1	2.0	6.7	1.7	2.3
0.91	0.93	0.84	0.89	0.87	0.95	0.96	0.92	0.97	0.96	0.90	0.97
14.7	23.4	7.87	5.63	9.09	12.65	15.45	30.69	22.56	22.68	33.85	26.52
5.2	4.6	10.4	15.3	19.0	27.4	26.7	27.0	24.5	16.2	14.5	2.9
-3.2	-4.1	3.2	3.5	8.5	15.2	16.4	15.1	12.0	3.5	2.7	-6.1
-8.8	-7.1	-3.5	2.2	8.4	13.6	16.4	16.3	11.9	6.2	-0.6	-5.5
136	194	214	308	417	500	476	451	359	218	145	127
28.4	75.2	46.0	20.8	121.2	101.3	86.4	84.3	33.3	102.9	69.6	121.7
6	10	10	8	12	15	11	9	8	7	5	11
45.0	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	32.5
21.4	41.9	39.9	6.75	451	446	215	251	112	324	144	384
0	0	0	0	0	0	0	0	0	0	0	0

41 45 N 88 19 W 30.5 IL AURORA COLLEGE

RWEQ INPUT FORM

CLIENT: CPI90WEATHER FILE: CPI90.W1MANAGEMENT FILE: CPI90.MAN

Soil Properties: soil texture
sand 72.4 %
silt 15.6 %
organic matter 3.6 %
calcium carbonate — %
rock cover — %

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation — degrees from north
*length_N — feet
*slope gradient —
*slope length — feet

EF: 0.47SCF: 0.52Longitude 87° 21'Latitude 41° 13'Elevation 636' (194m)Annual Rainfall 36" (915mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Can	
									Spac.	Ht.	Orient.									
1/10/90	NONE	0		0	NONE	CULT-30	Y	0.1	40	1	0	Y	70	90						
4/22/90	NONE	0		0	NONE	CULT-30	Y	0.1	30	3	0	N	70	90	0.58					
5/2/90	NONE	0		0	NONE	DISK-TAN	Y	0.2	0	0	0	N	50	26						
6/15/90	NONE	0		0	NONE	NONE	Y	0	0	0	0	N	0	0						
7/6/90	NONE	0		0	NONE	ROD-PLA	Y	0.2	0	0	0	N	90	50	0.29					
10/20/90	NONE	0		0	NONE	CULT-12	Y	0.2	100	3	0	N	75	50	0.61					
12/31/90	NONE	0		0	NONE	NONE	Y	0	0	0	0	N	0	0	0.51					

Soil Loss = 104.5 t/ac
= 23.42 kg/m²

APPENDIX K-6

CLIENT FILE: CPI91

CPI91.W1

14834 USA IL JOLIET modified for crown point jan91 to dec91

41 30 N 88 10 W 181 19460101 19521231 ARW 150 101

5.67	5.34	6.66	6.20	4.76	4.36	4.00	4.05	4.43	5.79	6.00	4.93
2.39	2.51	1.95	2.43	2.02	2.70	2.06	2.36	2.15	2.78	2.19	1.70
1.29	1.29	1.26	1.23	1.20	1.18	1.17	1.18	1.20	1.22	1.25	1.28
225	247	203	203	203	203	225	225	203	203	203	225
1.9	1.7	1.8	1.6	2.0	2.5	3.5	2.1	2.0	6.7	1.7	2.3
0.91	0.93	0.84	0.89	0.87	0.95	0.96	0.92	0.97	0.96	0.90	0.97
5.4	15.3	18.7	12.8	27.6	31.5	42.2	52.3	38.4	15.4	25.8	4.9
-2.1	3.3	9.0	17.3	25.3	29.7	29.4	28.6	24.7	17.9	6.6	3.6
-9.3	-4.0	-0.4	6.4	14.1	16.0	16.3	15.4	10.5	7.0	-2.8	-3.9
-8.8	-7.1	-3.5	2.2	8.4	13.6	16.4	16.3	11.9	6.2	-0.6	-5.5
172	209	242	381	399	566	526	406	383	241	136	106
9.1	6.1	72.4	81.8	127.8	1.3	19.8	79.2	40.9	180.3	69.1	26.7
2	3	13	14	14	1	3	9	7	14	15	9
45.0	14.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	32.5
2	3	48	116	528	.2	68	243	51	348	47	11
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

41 45 N 88 19 W 30.5 IL AURORA COLLEGE

RWEQ INPUT FORM

CLIENT: CPI91WEATHER FILE: CPI91.W1MANAGEMENT FILE: CPI91.MAN

Soil Properties: soil texture
sand 72.6 %
silt 15.6 %
organic matter 3.6 %
calcium carbonate 0 %
rock cover 0 %

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation - degrees from north
*length_N - feet
*slope gradient -
*slope length - feet

EF: 0.47
SCF: 0.52

Longitude 87° 21'Latitude 41° 13'Elevation 636' (194m)Annual Rainfall 36" (915mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Ca	
									Spac.	Ht.	Orient.									
1/1/91	NONE	0		0	NONE	NONE	Y	0.1	0	0	90	N	0	0						
3/25/91	NONE	0		0	NONE	CHI-STR	Y	0.2	15	1	0	N	70	70	0.36					
5/10/91	NONE	0		0	NONE	ROD-PLA	Y	0.2	0	0	0	N	90	50	0.43					
6/4/91	NONE	0		0	NONE	CULT 30	Y	0.7	18	1	0	N	70	90	0.44					
7/9/91	NONE	0		0	NONE	CULT 30	Y	0.7	18	1	0	N	70	90	0.66					
11/14/91	NONE	0		0	NONE	ROD-PLA	Y	0.4	0	0	0	N	90	50	0.39					
12/31/91	NONE	0		0	NONE	NONE	Y	0	0	0	0	N	100	100	0.44					

Soil Loss = 50.1 t/ac= 11.23 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \underline{3.0} \text{ t/ac} \\ &= \underline{.67} \text{ kg/m}^2\end{aligned}$$

CLIENT FILE: EKS90

EKS90.W1

#13985	KS DODGE CITY modified for Elkart KS	MAR-NOV 1990
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37	46	N	99	58	W	796	19610421	19781231	AGW	115	88			
4.87	5.27			5.94		6.82	7.18	6.90	4.93	6.42	6.77	5.45	5.97	6.94
1.63	1.79			1.77		2.27	2.54	2.31	2.03	2.86	2.66	2.03	2.27	2.72
1.19	1.18			1.15		1.12	1.11	1.09	1.08	1.08	1.10	1.13	1.16	1.18
0	0			0		180	180	180	180	180	180	180	0	0
6.6	3.4			2.7		3.1	3.6	5.8	4.1	4.7	5.7	5.5	3.4	3.8
0.81	0.89			0.69		0.58	0.73	0.89	0.95	0.86	0.64	0.55	0.65	0.75
6.3	5.82			7.91		1.53	.97	1.59	2.32	1.0	1.1	1.64	0.43	1.0
11.1	13.6			14.6		21.2	24.0	34.8	32.3	34.3	29.3	23.1	17.6	8.7
-5.3	-2.8			-0.4		4.2	8.3	16.5	17.1	18.6	14.0	4.3	0.6	-4.8
-6.6	-4.0			-2.4		3.8	10.9	15.4	17.3	16.1	11.8	6.2	-0.5	-4.6
249	294			381		509	579	673	604	734	610	373	177	298
12	7			21		44	81	25	140	74	64	7	25	18
0.0	0.0			8		7	5	4	13	5.7	5.0	1	3	2.9
10.7	30.4			6.3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	13.8
6	1			13		106	196	91	950	332	254	3	35	19
0.0	0.0			0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	16	N	99	19	W	79.8	KS	COLDWATER	A					

RWEQ INPUT FORM

CLIENT: EKS90

WEATHER FILE: EKS90.W1

MANAGEMENT FILE: EKS90.MAN

Soil Properties:	soil texture		
	sand	<u>68.1</u>	%
	silt	<u>21.5</u>	%
	organic matter	<u>1.33</u>	%
	calcium carbonate	—	%
	rock cover	—	%

Field Geometry:

*shape	<u>circular</u> or rectangular
*area	<u>6.5</u> , acres
*orientation	<u>-</u> , degrees from north
*length_N	<u>-</u> , feet
*slope gradient	<u>-</u>
*slope length	<u>-</u> , feet

EF: 0.53
SCF: 0.58

Longitude 101° 52'

Latitude 37° 05'

Elevation 3484 (1062m)

Annual Rainfall 16.77" (426mm)

[illegible]

Soil Loss = 2.8 t/ac
= .63 kg/m²

APPENDIX K-9

CLIENT FILE: EKS91

EKS91.W1

#13985 KS DODGE_CITY modified for Elkart KS JAN 91 TO DEC 91

37 46 N 99 58 W 796 19610421 19781231 AGW 115 88

4.52	5.29	6.78	6.38	7.37	6.16	5.33	4.67	5.72	5.18	5.15	3.98
1.81	1.99	1.77	1.77	2.47	2.27	2.26	2.17	2.62	2.05	2.24	1.70
1.19	1.18	1.15	1.12	1.11	1.09	1.08	1.08	1.10	1.13	1.16	1.18
0	0	0	180	180	180	180	180	180	180	0	0
6.6	3.4	2.7	3.1	3.6	5.8	4.1	4.7	5.7	5.5	3.4	3.8
0.81	0.89	0.69	0.58	0.73	0.89	0.95	0.86	0.64	0.55	0.65	0.75
4.08	1.36	0.51	0.75	1.67	8.29	18.3	3.96	7.54	14.0	18.3	9.21
7.1	16.5	18.0	20.8	27.7	31.1	33.9	31.9	27.2	22.8	10.6	8.7
-7.3	-4.1	1.1	4.8	10.6	15.8	17.4	17.0	11.5	3.3	-4.4	-4.4
-6.6	-4.0	-2.4	3.8	10.9	15.4	17.3	16.1	11.8	6.2	-0.5	-4.6
246	358	404	516	583	618	585	554	432	379	235	183
2.3	0	2.8	8.1	67.1	81.5	9.9	78.5	20.1	8.9	37.6	28.4
4.0	0.0	1.0	6.0	7.0	9.0	3.0	9.0	4.0	1.0	9.0	7.0
10.7	30.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	13.8
.2	0.0	1.5	3.7	276	352	36	288	20	7.7	34	8.3
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

37 16 N 99 19 W 79.8 KS COLDWATER A

RWEQ INPUT FORM

CLIENT: EKS91WEATHER FILE: EKS91.W1MANAGEMENT FILE: EKS91.MAN

Soil Properties: soil texture
sand 68.1%
silt 21.5%
organic matter 1.33%
calcium carbonate -%
rock cover -%

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation - degrees from north
*length N - feet
*slope gradient -
*slope length - feet

EF: 0.53
SCF: 0.58

Longitude 101° 52'Latitude 37° 05'Elevation 3484 (1062m)Annual Rainfall 16.77" (424mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Can	
									Spac.	Ht.	Orient.									
1/1/91	WWHEAT	0	10	0	NONE	DISK-TAN	Y	0.8	0	0	0	Y	100	100	0.37					
4/16/91	WWHEAT	0	10	0	WWHEAT	NONE	N	0	0	0	0	N	100	100		0.39	0.88			
12/30/91	WWHEAT	0	10	0	NONE	NONE	N	0	0	0	0	N	100	100	0.58	0.95	0.95			

Soil Loss - 15.2 t/uc
= 3.41 kg/m²

Soil Loss = 92.5 t/ac
= 20.73 kg/m²

CLIENT FILE: EKS93

EKS93.W1

13985 USA KS DODGE CITY

37	46	N 99	58 W 79.6	19610421	19781231	AGW	115	88				
4.86	4.92	6.33	7.30	7.43	7.20	6.70	6.42	6.77	6.88	6.82	6.94	
1.89	1.46	2.21	2.51	2.73	2.66	2.85	2.86	2.66	2.69	2.65	2.72	
1.19	1.18	1.15	1.12	1.11	1.09	1.08	1.08	1.10	1.13	1.16	1.18	
0	0	0	180	180	180	180	180	180	180	0	0	
6.6	3.4	2.7	3.1	3.6	5.8	4.1	4.7	5.7	5.5	3.4	3.8	
0.81	0.89	0.69	0.58	0.73	0.89	0.95	0.86	0.64	0.55	0.65	0.75	
25.5	7.3	4.3	4.1	.9	1.3	.8	1.0	1.1	.9	1.2	1.0	
4.9	7.9	14.2	19.8	26.5	32.1	35.0	34.3	29.3	23.4	14.3	8.7	
-8.3	-6.7	-0.9	3.6	11.7	17.0	19.7	18.6	14.0	7.7	0.2	-4.8	
-6.6	-4.0	-2.4	3.8	10.9	15.4	17.3	16.1	11.8	6.2	-0.5	-4.6	
208	283	401	512	733	801	825	734	610	472	352	298	
11	6	32	36	91	98	77	74	64	47	27	18	
3	6	8	5	7.7	7.0	6.3	5.7	5.0	3.5	3.4	2.9	
10.7	30.4	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	13.8	
12	0.7	21	107	195	469	469	332	254	97	58	19	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
37	16	N 99	19 W 79.8	KS COLDWATER A								

RWEQ INPUT FORM

CLIENT: EKS93

WEATHER FILE: *EKS93,W1*

MANAGEMENT FILE: EKS93,MAN

Soil Properties:		
soil texture		
sand	48.1	%
silt	21.5	%
organic matter	1.33	%
calcium carbonate	-	%
rock cover	-	%

Field Geometry: *shape circular or rectangular
 *area 6.5 , acres
 *orientation , degrees from north
 *length_N , feet
 *slope gradient
 *slope length , feet

EF: 0.53
SCF: 0.58

Longitude 101° 52'

Latitude 37° 05'

Elevation 3484' (1062m)

Annual Rainfall 16.77" (426mm)

[illegible]

Soil Loss = 61.2 t/ac
= 13.72 kg/m²

APPENDIX K-12

CLIENT FILE: CM89

CM89.W1

14916 USA ND GRAND FORKS modified for Crookston, MN JAN-DEC 1989

47 56 N 97 05 W 259 19491105 19581231 ARW 70 66

6.97	6.03	5.54	6.91	6.06	5.18	3.88	5.54	5.83	6.32	6.65	6.48
1.95	1.81	1.75	2.58	1.61	1.79	1.80	2.11	1.97	1.89	1.84	1.77
1.34	1.32	1.29	1.24	1.20	1.18	1.17	1.17	1.20	1.22	1.27	1.31
338	338	338	337	338	292	315	158	337	337	337	338
5.6	4.1	3.4	3.0	1.8	1.6	1.6	2.7	1.7	3.0	3.2	3.5
0.89	0.82	0.90	0.86	0.60	0.87	0.69	0.52	0.68	0.73	0.94	0.86
15.8	10.4	10.2	4.2	4.3	9.0	15.6	10.5	8.9	11.3	5.9	8.9
-6.3	-11.7	-1.7	10.5	21.4	24.5	31.3	28.2	21.5	14.5	-0.3	-11.7
-20.5	-25.1	-12.4	0.3	7.1	10.4	14.9	13.3	7.0	-1.5	-10.9	-22.4
-19.6	-15.9	-10.3	-2.1	3.6	10.1	13.4	12.5	7.0	1.4	-6.9	-14.6
135	254	301	401	485	523	533	429	349	214	126	97
0	0	0	11	105	51	12	116	21	17	8	0
0	0	0	6	10	12	4	9	3	5	5	0
87.4	75.5	34.8	0.0	0.0	0.0	0.0	0.0	0.0	7.5	57.0	79.8
0	0	0	3	638	95	7	681	34	67	1	0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

48 19 N 96 46 W 48.7 MN ARGYLE E

RWEQ INPUT FORM

CLIENT: CM89WEATHER FILE: CM89.W1MANAGEMENT FILE: CM89.MAN

Soil Properties: soil texture
sand 10 %
silt 56 %
organic matter 2 %
calcium carbonate 3 %
rock cover - %

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation - degrees from north
*length_N - feet
*slope gradient -
*slope length - feet

EF: 0.34SCF: 0.12Longitude 96° 40'Latitude 47° 45'Elevation 867' (263m)Annual Rainfall 20.35" (512mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough	RR	-----Ridge-----			Kill Crop	% Flat	% Stand	EF	K ⊥	K ∥	Sil	Can	
									Spec.	1ft	Orient.									
11/7/88	CORN	0	30	0	NONE	DISK-TAN	Y	1.4	0	0	0	Y	100	100						
2/1/89	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
4/1/89	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
5/5/89	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
5/6/89	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
6/1/89	CORN	0		0	CORN	PLAN-ROW	Y	0.2	36	2	0	N	90	50						
6/15/89	CORN	0		0	CORN	CULT-12	Y	0.7	14	1	0	N	75	50						
8/1/89	CORN	0		0	CORN	NONE	N	0	0	0	0	N	100	100						
10/30/89	CORN	6000		10	NONE	HARVEST	N	0	0	0	0	Y	100	100						
11/1/89	CORN	0		0	NONE	MOLDB8	Y	1.9	0	0	0	N	5	0						

Soil Loss = 0 t/ac
= 0 kg/m²

CLIENT FILE: CM90

CM90.W1

14916 USA ND GRAND FORKS

CROOKSTON, MN 1990

47 56 N 97 05 W 259 19491105 19581231 ARW 70 66

6.55	7.21	6.53	7.86	6.23	5.04	4.27	4.64	5.74	6.74	6.65	6.48
1.51	2.49	1.89	2.58	1.89	1.51	2.19	1.78	2.08	2.25	1.84	1.77
1.34	1.32	1.29	1.24	1.20	1.18	1.17	1.17	1.20	1.22	1.27	1.31
338	338	338	337	338	292	315	158	337	337	337	338
5.6	4.1	3.4	3.0	1.8	1.6	1.6	2.7	1.7	3.0	3.2	3.5
0.89	0.82	0.90	0.86	0.60	0.87	0.69	0.52	0.68	0.73	0.94	0.86
6.05	5.5	3.4	3.4	3.1	7.3	10.7	8.8	6.2	.6	5.91	8.88
-2.6	-1.9	4.2	12.0	21.1	24.3	28.1	28.6	26.1	13.2	-0.3	10.9
-13.0	-14.6	-6.5	-0.6	5.2	12.4	12.6	13.4	10.9	0.3	-10.9	-8.3
-19.6	-15.9	-10.3	-2.1	3.6	10.1	13.4	12.5	7.0	1.4	-6.9	-14.6
114	198	323	411	512	493	504	486	392	319	126	93
0	0	0.3	0	21	73	18	53	5	32	7.6	0
0	0	1	0	2	14	6	9	3	5.1	5	0
87.4	75.5	34.8	0.0	0.0	0.0	0.0	0.0	0.0	7.5	57.0	79.8
0	0	.1	0	122	77	28	256	2	135	1.2	0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

48 19 N 96 46 W 48.7 MN ARGYLE E

RWEQ INPUT FORM

CLIENT: CM90WEATHER FILE: CM90.W1MANAGEMENT FILE: CM90.MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

10 %
56 %
2 %
3 %
- %

Field Geometry:

*shape circular or rectangular
*area 6.5 acres
*orientation - degrees from north
*length_N - feet
*slope gradient -
*slope length - feet

EF: 0.34SCF: 0.12Longitude 96° 40'Latitude 47° 45'Elevation 867' (263m)Annual Rainfall 20.35" (512mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	Std. Dev.	-----Ridge-----			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Can	
									Spac.	1ft.	Orient.									
11/2/89	CORN	6000		10	NONE	HARVEST	N	0	0	0	0	Y	100	100						
11/27/89	CORN	0		0	NONE	DISK-TAN	Y	1.3	0	0	0	N	100	100						
2/1/90	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
4/1/90	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
5/6/90	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						

Soil Loss = 0 t/ac= 0 kg/m²

CLIENT FILE: SLM91

SLM91.W1

14910 USA MN ALEXANDRIA modified for Swan Lake APR-DEC 1991

45 52 N 95 23 W 435 19481201 19541231 ARW 88 86 SLM91.W1

6.83	5.29	7.41	7.77	4.60	5.36	4.92	4.14	4.81	5.75	7.16	6.13
2.66	1.67	2.19	2.47	2.02	2.05	2.11	2.44	1.97	2.07	1.75	1.68
1.31	1.28	1.26	1.21	1.17	1.15	1.14	1.15	1.17	1.20	1.24	1.27
293	293	293	293	293	270	315	158	293	315	315	293
3.2	2.9	1.9	1.9	2.1	2.0	1.7	1.6	3.0	1.9	3.5	3.8
0.84	0.83	0.69	0.74	0.80	0.89	0.53	0.60	0.85	0.78	0.94	0.86
6.9	5.4	5.6	4.2	7.0	4.3	9.4	11.8	8.1	2.8	2.5	6.9
-6.6	0.9	4.0	12.8	27.0	26.8	28.6	33.1	72.5	20.6	5.3	25.8
-19.1	-11.1	-5.9	2.7	14.3	16.4	17.3	20.8	51.9	3.4	-7.8	-7.1
-16.8	-13.2	-8.0	-0.8	4.8	12.1	14.8	14.4	8.5	2.6	-5.4	-11.7
137	226	232	389	498	493	512	465	460	311	181	84
0.8	1.0	18.5	59.2	3	16.8	7	31	3.7	19.1	6.6	1.0
1	3	8	9	5	11	9	9	10.0	4.0	2.0	2.0
80.0	58.8	12.8	0.8	0.0	0.0	0.0	0.0	0.0	1.8	28.0	76.6
.1	.1	5.0	37	.2	3.2	3.3	27	23.3	18.8	1.2	0.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

45 39 N 95 24 W 24.1 MN GLENWOOD W

RWEQ INPUT FORM

CLIENT: SLM91WEATHER FILE: SLM91.W1MANAGEMENT FILE: SLM91.MAN

Soil Properties: soil texture
sand 27.8 %
silt 46.7 %
organic matter 1.24 %
calcium carbonate — %
rock cover — %

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation — degrees from north
*length_N — feet
*slope gradient — %
*slope length — feet

EF: 0.43SCF: 0.19Longitude 95° 55'Latitude 45° 35'Elevation 1150' (348m)Annual Rainfall 23.46" (596mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand	EF	K └	K 	Sil	Can	
									Spac.	Ht.	Orient.									
4/11/91	CORN	0		0	NONE	NONE	N	0	0	0	0	Y	100	100						
5/21/91	CORN	0		0	NONE	CULT-12	Y	0.7	14	1	0	N	75	50						
7/9/91	CORN	0		0	SOYBEAN	DRILL-DI	Y	0.3	12	1	0	N	90	40						
10/14/91	SOYBEAN	2000		0	NONE	HARVEST	N	0	0	0	0	Y	100	100						
10/22/91	SOYBEAN	0	20	0	NONE	MOLD-B	Y	1.9	0	0	0	N	5	0						
12/30/91	SOYBEAN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
12/31/91	SOYBEAN	0		0	NONE	NONE	N	0	0	0	0	N	100	100		0.26	0.26			

Soil Loss = 11.2 t/ac= 2.51 kg/m²

CLIENT FILE: SLM92

SLM92.W1

14910 USA MN ALEXANDRIA modified for Swan Lake JAN-APR 92, DEC 92

45 52 N 95 23 W 435 19481201 19541231 ARW 88 86

6.39	6.48	6.36	6.18	6.43	5.97	5.28	5.19	5.87	6.35	6.90	6.66
1.70	2.22	2.62	1.95	2.15	2.15	2.33	2.32	2.19	2.26	2.21	1.90
1.31	1.28	1.26	1.21	1.17	1.15	1.14	1.15	1.17	1.20	1.24	1.27
293	293	293	293	293	270	315	158	293	315	315	293
3.2	2.9	1.9	1.9	2.1	2.0	1.7	1.6	3.0	1.9	3.5	3.8
0.84	0.83	0.69	0.74	0.80	0.89	0.53	0.60	0.85	0.78	0.94	0.86
16.0	2.5	4.2	2.1	.8	1.0	1.6	1.5	1.7	1.1	1.2	4.6
-7.3	-3.5	2.3	12.1	20.0	25.1	28.1	27.1	21.4	15.1	4.6	-4.0
-19.1	-15.6	-8.8	0.0	7.0	12.3	15.2	14.2	8.3	2.8	-5.4	-14.2
-16.8	-13.2	-8.0	-0.8	4.8	12.1	14.8	14.4	8.5	2.6	-5.4	-11.7
209	297	467	535	653	681	733	632	460	311	181	154
4.6	2.3	2.8	30.2	73	92	80	81	55	50	27	0.8
6	3	5	8	10.0	10.9	8.8	8.4	7.5	6.5	5.3	2
80.0	58.8	12.8	0.8	0.0	0.0	0.0	0.0	0.0	1.8	28.0	76.6
1.05	0.23	0.41	9.00	59	254	389	419	269	59	15	0.07
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

45 39 N 95 24 W 24.1 MN GLENWOOD W

RWEQ INPUT FORM

CLIENT: SLM92WEATHER FILE: SLM92.W1MANAGEMENT FILE: SLM92.MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

27.8 %
46.7 %
1.24 %
— %
— %

Field Geometry: *shape
*area
*orientation
*length_N
*slope gradient
*slope length

circular or rectangular
6.5 acres
— degrees from north
— feet
—
— feet

EF: 0.43SCF: 0.19Longitude 95° 55'Latitude 45° 35'Elevation 1150' (348m)Annual Rainfall 23.5" (596mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Can	
									Spac.	Ht.	Orient.									
1/1/92	SOYBEAN	0	10	0	NONE	NONE	Y	1.2	0	0	0	Y	100	100						
3/1/92	SOYBEAN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
4/1/92	SOYBEAN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
5/27/92	SOYBEAN	0		0	NONE	CULT-12	Y	0.7	14	1	0	N	75	50						
6/9/92	SOYBEAN	0		0	CORN	PLAN-ROW	Y	0.2	36	2	0	N	90	50						
6/25/92	SOYBEAN	0		0	CORN	CULT-12	Y	0.7	14	1	0	N	75	50						
10/24/92	CORN	6000		10	NONE	HARVEST	N	0	0	0	0	Y	100	100						
10/30/92	CORN	0		0	NONE	MALDB8	Y	1.9	0	0	0	N	5	0						
12/30/92	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
12/31/92	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						

Soil Loss = 0.2 t/ac
= .04 kg/m²

APPENDIX K-16

CLIENT FILE: SLM93

SLM93.W1

14910 USA MN ALEXANDRIA modified for Swan Lake JAN-JUN 93, NOV-DEC 93

45 52 N 95 23 W 435 19481201 19541231 ARW 88 86

6.16	4.69	6.56	5.78	6.57	5.73	5.28	5.19	5.87	6.35	5.41	5.95
1.93	1.85	2.07	2.21	2.13	1.98	2.33	2.32	2.19	2.26	2.08	2.10
1.31	1.28	1.26	1.21	1.17	1.15	1.14	1.15	1.17	1.20	1.24	1.27
293	293	293	293	293	270	315	158	293	315	315	293
3.2	2.9	1.9	1.9	2.1	2.0	1.7	1.6	3.0	1.9	3.5	3.8
0.84	0.83	0.69	0.74	0.80	0.89	0.53	0.60	0.85	0.78	0.94	0.86
6.38	25.69	10.62	4.67	2.54	3.74	1.6	1.5	1.7	1.1	12.0	9.3
-7.5	-6.5	1.6	11.1	18.6	21.3	28.1	27.1	21.4	15.1	-0.1	-4.4
-18.6	-16.5	-9.5	-0.2	7.4	11.9	15.2	14.2	8.3	2.8	-7.3	-13.8
-16.8	-13.2	-8.0	-0.8	4.8	12.1	14.8	14.4	8.5	2.6	-5.4	-11.7
142	237	327	385	445	445	733	632	460	311	123	107
1.0	1.3	25.9	37.8	178.6	149.1	80	81	55	50	22	3
2	2	4	10	14	14	8.8	8.4	7.5	6.5	4	1
80.0	58.8	12.8	0.8	0.0	0.0	0.0	0.0	0.0	1.8	28.0	76.6
0.12	0.17	7.12	11.19	837.2	269.2	389	419	269	59	20.7	1.1
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

45 39 N 95 24 W 24.1 MN GLENWOOD W

RWEQ INPUT FORM

CLIENT: SLM93WEATHER FILE: SLM93.W1MANAGEMENT FILE: SLM93.MAN

Soil Properties: soil texture
sand 27.8 %
silt 46.7 %
organic matter 1.24 %
calcium carbonate - %
rock cover - %

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation - degrees from north
*length_N - feet
*slope gradient -
*slope length - feet

EF: 0.43SCF: 0.14Longitude 95° 55'Latitude 45° 35'Elevation 1150' (348m)Annual Rainfall 23.5" (596mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Ca	
									Spac.	Ht.	Orient.									
1/1/93	CORN	0	15	0	NONE	NONE	Y	1.3	0	0	0	Y	100	100						
3/1/93	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
4/1/93	CORN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
4/24/93	CORN	0		0	NONE	CULT-12	Y	0.7	14	1	0	N	75	50						
4/7/93	CORN	0		0	SOYBEAN	DRILL-DD	Y	0.3	12	1	0	N	90	40						
6/25/93	CORN	0		0	SOYBEAN	NONE	N	0	0	0	0	N	100	100						
10/24/93	SOYBEAN	2000		20	NONE	HARVEST	N	0	0	0	0	Y	100	100						
10/30/93	SOYBEAN	0		0	NONE	MOLDBB	Y	1.9	0	0	0	N	5	0						
12/30/93	SOYBEAN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
12/31/93	SOYBEAN	0		0	NONE	NONE	N	0	0	0	0	N	100	100						

Soil Loss = 0 t/ac
= 0 kg/m²

CLIENT FILE: KM93

KM93.W1

13814 USA AR BLYTHEVILLE MODIFIED FOR KENNETT DEC 92 THRU JUN 93

35 58 N 89 57 W 80 19600501 19701231 AGA 280 106

[illegible]

35 32 N 89 39 W 55.3 TN COVINGTON

RWEO INPUT FORM

CLIENT: KM93

WEATHER FILE: *KM93.W1*

MANAGEMENT FILE: *KM93.MAN*

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

- *shape
- *area
- *orientation
- *length_N
- *slope gradient
- *slope length

circular or rectangular
6.5 acres
 _____, degrees from north
 _____, feet
 _____, feet

EF: 0.66
SCF: 0.94

Longitude $89^{\circ} 59.67'$

Latitude 36° 22.45'

Elevation 463' (141m)

Annual Rainfall 49.4" (1253mm)

[illegible]
$$\begin{aligned}\text{Soil Loss} &= \underline{24.2} \text{ t/ac} \\ &= \underline{5.42} \text{ kg/m}^2\end{aligned}$$

CLIENT FILE: KM94

KM94.W1

13814 USA AR BLYTHEVILLE MODIFIED FOR KENNETT JAN THRU APR 94

35 58 N 89 57 W 80 19600501 19701231 AGA 280 106

[illegible]

35 32 N 89 39 W 55.3 TN COVINGTON

RWEQ INPUT FORM

CLIENT: KM94

WEATHER FILE: KM94.W1

MANAGEMENT FILE: KM94, MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

*shape	<u>circular</u> or rectangular
*area	<u>6.5</u> , acres
*orientation	—, degrees from north
*length_N	—, feet
*slope gradient	—
*slope length	—, feet

EF: 0.66
SCF: 0.94

Longitude 89° 59.67' Latitude 36° 22.45' Elevation 463' (141m) Annual Rainfall 49.4" (1255mm)

[illegible]
$$\begin{aligned}\text{Soil Loss} &= \underline{7.8} \text{ t/ac} \\ &= \underline{1.75} \text{ kg/m}^2\end{aligned}$$

$$\begin{aligned}\text{Soil Loss} &= \underline{19.8} \text{ t/ac} \\ &= \underline{4.44} \text{ kg/m}^2\end{aligned}$$

Soil Loss = 2.3 t/ac
= 0.52 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \underline{8.8} \text{ t/ac} \\ &= \underline{1.97} \text{ kg/m}^2\end{aligned}$$

$$\begin{aligned}\text{Soil Loss} &= \underline{9.0} \text{ t/ac} \\ &= \underline{2.02} \text{ kg/m}^2\end{aligned}$$

CLIENT FILE: SM89

SM89.W1

#	94008	USA MT	GLASGOW	modified for Scobey, MT						OCT 88 - MAR 89		
48 13	N 106	37 W 696	19680601	19781231	AGW	30	43					
	7.45	6.92	4.84	7.24	6.62	6.29	5.94	6.11	6.10	5.00	5.14	5.26
	2.82	2.07	1.94	2.38	2.37	2.38	2.48	2.54	2.32	1.29	1.77	1.80
	1.26	1.23	1.20	1.16	1.14	1.11	1.11	1.11	1.13	1.16	1.20	1.23
	293	113	293	293	112	292	293	293	293	315	293	293
	3.4	7.1	2.3	2.0	2.2	2.0	2.6	2.3	2.4	3.4	3.6	3.8
	0.64	0.74	0.51	0.58	0.55	0.68	0.84	0.61	0.76	0.93	0.85	0.54
	3.6	2.0	7.7	2.2	2.0	2.0	2.8	1.8	3.1	8.4	10.9	5.0
	-4.0	11.5	-0.5	16.6	21.8	27.2	32.2	28.7	24.1	8.3	2.6	-4.1
	-15.0	21.4	-10.7	-0.5	5.7	9.8	13.6	11.0	5.6	-4.6	-7.7	-14.7
	-14.7	-12.0	-7.9	-3.0	3.0	8.0	10.4	8.3	4.1	-0.8	-5.6	-11.4
	139	245	297	553	702	738	819	684	505	145	138	102
	0.3	0	4.1	13	50	63	47	40	27	1.0	1.0	3.0
	1	0	3	2.9	6.8	7.1	5.6	4.7	3.6	2	3	3
	74.7	50.3	19.2	0.0	0.0	0.0	0.0	0.0	100.0	3.4	28.1	68.0
	0	0	0.6	0	13	98	187	132	63	.1	.1	.4
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48 4	N 105	37 W 76.0	MT	WOLF POINT								

RWEQ INPUT FORM

CLIENT: SM89

WEATHER FILE: SM89, W1

MANAGEMENT FILE: SM89,MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

- *shape
- *area
- *orientation
- *length_N
- *slope gradient
- *slope length

circular or rectangular
6.5, acres
 _____, degrees from north
 _____, feet
 _____, feet

EF: 0.42

SCF: 0.27

Longitude $105^{\circ} 15'$

Latitude $48^{\circ} 48'$

Elevation 2830' (850m)

Annual Rainfall 13.7" (348mm)

[illegible]

Soil Loss = 32.9 t/ac
= 7.37 kg/m²

Soil Loss = 0.3 t/ac
= 0.07 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \underline{0} \text{ t/ac} \\ &= \underline{0} \text{ kg/m}^2\end{aligned}$$

CLIENT FILE: SN89

SN89.W1

```
# 24030 USA NE SIDNEY modified for sidney jan89 to may89,nov88 to dec88
```

41 08 N 103 02 W 1231 19491221 19541231 ARF 60 87

[illegible]

41 45 N 102 25 W 85.7 NE CRESCENT LK GAME RF

RWEQ INPUT FORM

CLIENT: SN 89

WEATHER FILE: SN89.W1

MANAGEMENT FILE: SN89. MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

*shape	<u>circle</u> or rectangular
*area	<u>6.5</u> acres
*orientation	<u>-</u> degrees from north
*length_N	<u>-</u> feet
*slope gradient	<u>-</u>
*slope length	<u>-</u> feet

EF: 0.42
SCF: 0.31

Longitude 103° 0'

Latitude 41° 13'

Elevation 4301' (1311m)

Annual Rainfall 16.0" (406mm)

[illegible]

Soil Loss = 2.3 t/ac
= 0.52 kg/m²

CLIENT FILE: SN90

SN90.W1

```
# 24030 USA NE SIDNEY modified for sidney jan90 to may90,nov89 to dec89
```

41	08	N 103	02	W 1231	1949	1221	1954	1231	ARF	60	87	
6.24	5.36	6.11	5.35	6.79	6.32	5.90	5.49	5.54	5.65	6.65	6.08	
1.79	1.73	1.64	1.88	2.27	2.36	2.53	2.47	2.30	2.34	2.07	2.09	
1.12	1.11	1.10	1.08	1.06	1.03	1.03	1.03	1.05	1.07	1.10	1.11	
293	293	315	337	337	157	157	157	158	315	337	315	
3.7	2.2	2.5	3.4	2.1	2.7	4.4	1.4	3.1	2.0	2.3	2.1	
0.97	0.98	0.95	0.66	0.51	0.57	0.82	0.71	0.61	0.86	0.86	0.98	
6.5	10.2	9.5	10.9	1.5	2.4	3.8	4.2	4.2	4.1	8.7	5.51	
6.3	3.8	9.1	14.9	21.1	26.6	30.4	30.0	25.1	19.1	11.4	1.3	
-7.4	-8.7	-4.3	0.1	5.7	10.8	13.9	12.8	6.9	0.3	-4.5	-11.9	
-10.6	-8.4	-6.3	-1.2	5.0	10.7	13.3	12.7	6.9	0.9	-5.5	-8.5	
217	240	371	459	696	765	772	681	537	410	230	183	
2.5	0.8	24.6	10.2	83	80	63	50	36	21	3.8	0.3	
2	2	9	8	10.5	10.1	8.6	7.1	5.1	4.0	2	1	
38.4	22.9	21.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	18.1	
.68	.04	14.7	2.5	71	194	265	224	143	71	3	.01	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
41	45	N 102	25	W 85.7	NE	CRESCENT LK	GAME RF					

RWEQ INPUT FORM

CLIENT: SN90

WEATHER FILE: SNEG0.W1

MANAGEMENT FILE: SN 90. MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

*shape	<u>circular or rectangular</u>
*area	<u>6.5</u> acres
*orientation	<u>—</u> degrees from north
*length_N	<u>—</u> feet
*slope gradient	<u>—</u>
*slope length	<u>—</u> feet

EF: 0.42
SCF: 0.31

Longitude 103° 0'

Latitude $41^{\circ} 13'$

Elevation 4301' (1311m)

Annual Rainfall 16.0" (406mm)

[illegible]
$$\begin{aligned}\text{Soil Loss} &= \underline{0.2} \text{ t/ac} \\ &= \underline{0.04} \text{ kg/m}^2\end{aligned}$$

Soil Loss = 19.8 t/ac
= 4.44 kg/m²

Soil Loss = 0.4 t/ac
= 0.09 kg/m²

CLIENT FILE: FND95

FND95.W1

14914 USA ND FARGO modified for Fargo, ND JAN-APR and OCT-DEC 95
 46 54 N 96 48 W 278 19610626 19781231 AGW 80 66
 4.44 4.71 6.12 6.03 6.80 6.18 5.74 6.00 6.34 6.63 6.45 5.87
 2.60 1.60 2.38 2.22 2.48 2.45 2.45 2.52 2.49 2.43 2.44 1.65
 1.33 1.31 1.27 1.23 1.19 1.17 1.16 1.16 1.19 1.22 1.26 1.31
 338 0 0 338 0 180 338 158 158 338 338 0
 4.1 3.6 4.3 3.4 2.5 2.2 2.3 2.2 2.3 2.9 2.4 3.7
 0.67 0.87 0.84 0.73 0.53 0.63 0.55 0.62 0.55 0.65 0.76 0.83
 1.5 4.1 6.2 7.8 2.5 4.0 4.1 3.9 3.5 2.6 4.1 7.4
 -10.3 -5.4 2.0 8.5 20.7 25.8 28.8 28.1 22.0 14.8 -1.3 -7.5
 -18.7 -18.7 -7.2 0.5 6.6 12.2 15.1 14.0 8.2 2.2 -10.3 -15.7
 -17.4 -13.7 -8.0 -0.6 4.7 12.3 15.0 14.1 8.1 2.4 -5.5 -12.5
 212 225 267 313 673 708 754 659 491 349 207 167
 0 2 41.4 10.7 62 95 97 78 55 45 .3 0
 0 3 9 4 6.6 7.8 6.9 6.1 5.6 5.1 1 0
 80.9 67.1 20.6 0.0 0.0 0.0 0.0 0.0 0.0 4.2 41.1 78.3
 0 .16 10.7 4.7 34 54 166 543 320 155 0.01 0
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 46 28 N 96 15 W 63.9 MN ROTHSA Y T

RWEQ INPUT FORM

CLIENT: FND95WEATHER FILE: FND95.W1MANAGEMENT FILE: FND95.MAN

Soil Properties: soil texture _____
 sand 10 %
 silt 40 %
 organic matter 7 %
 calcium carbonate 1 %
 rock cover - %

Field Geometry: *shape circular or rectangular
 *area 6.5 acres
 *orientation - degrees from north
 *length_N - feet
 *slope gradient -
 *slope length - feet

EF: 0.20SCF: 0.06Longitude 96° 53.67'Latitude 46° 56.13'Elevation 896' (271m)Annual Rainfall 19" (483mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	Ridge			Kill Crop	% Flat	% Stand.	EF	K	K		Sil	Can
12/6/94	Sbarley	0	28	0	NONE	DISK-TAN	Y	0.8	12	1	0	Y	100	100	0.17	.11	.64	28		
2/1/95	Sbarley	0		0	NONE	NONE	N	0	0	0	0	N	100	100						
5/6/95	Sbarley	0		0	NONE	NONE	N	0	0	0	0	N	100	100	0.07					
5/7/95	Sbarley	0		0	NONE	NONE	N	0	0	0	0	N	100	100						

Soil Loss = 0 t/ac
 = 0 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \frac{0}{1} \text{ t/ac} \\ &= 0 \text{ kg/m}^2\end{aligned}$$

$$\begin{aligned}\text{Soil Loss} &= \frac{0}{1} \text{ t/ac} \\ &= 0 \text{ kg/m}^2\end{aligned}$$

Soil Loss = 112.7 t/ac
= 25.26 kg/m²

CLIENT FILE: BST90

BST90.W1

#	23005	USA TX	BIG_SPRING	modified for Big Spring, TX						JAN-MAY	1990	
32	14	N 101	30 W 784	1959	0507	1970	1231	AGA	95	91		
	5.68	6.07	6.21	5.90	6.62	6.80	5.97	5.52	5.68	5.93	5.83	5.70
	2.11	2.30	2.05	2.00	3.05	2.68	2.82	2.61	2.47	2.26	2.15	2.12
	1.17	1.15	1.13	1.10	1.09	1.08	1.07	1.08	1.09	1.11	1.14	1.16
	247	45	247	225	180	180	180	180	180	180	180	225
	1.3	1.5	1.2	1.0	2.1	5.1	3.7	1.6	3.5	3.6	2.1	1.5
	0.70	0.56	0.71	0.79	0.86	0.93	0.96	0.85	0.75	0.80	0.64	0.60
	5	5.2	5.6	3.4	3.4	3.8	4.0	4.7	6.1	7.2	7.8	9.5
	17.1	18.9	19.6	24.8	30.3	33.7	34.7	34.2	30.6	25.7	19.0	15.3
	0.5	2.6	6.8	10.8	15.2	19.5	21.6	20.9	17.3	11.4	4.5	0.4
	-3.1	-1.3	-1.0	4.0	10.5	14.9	16.0	15.2	13.7	8.5	1.9	-1.6
	294	349	319	474	582	844	845	766	668	527	411	357
	27	44	34	65	7	49	47	45	67	42	16	14
	3	7	10	7	3	4.6	4.8	5.0	5.5	4.5	2.9	2.7
	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
	72	153	86	177	3	371	226	226	226	226	64	16
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	13	N 101	30 W 1.9	TX	BIG SPRING	WB	AP					

RWEQ INPUT FORM

CLIENT: BST90 WEATHER FILE: BST90.W1 MANAGEMENT FILE: BST90.MAN

Soil Properties:	soil texture	<u> </u>	Field Geometry:	*shape	<u>circular or rectangular</u>	EF: <u>0.59</u>
	sand	<u>83.6</u> %		*area	<u>6.5</u> acres	
	silt	<u>0.4</u> %		*orientation	<u> </u> degrees from north	SCF: <u>0.70</u>
	organic matter	<u>0.29</u> %		*length_N	<u> </u> feet	
	calcium carbonate	<u> </u> %		*slope gradient	<u> </u>	
	rock cover	<u> </u> %		*slope length	<u> </u> feet	

Longitude 101° 29.19' Latitude 32° 16.21' Elevation 2690' (820m) Annual Rainfall 18.5" (470mm)

[illegible]

Soil Loss = 76.1 t/ac
- 17.06 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \underline{0.5} \text{ t/ac} \\ &= \underline{0.11} \text{ kg/m}^2\end{aligned}$$

$$\begin{aligned}\text{Soil Loss} &= \underline{133.2} \text{ t/ac} \\ &= \underline{29.85} \text{ kg/m}^2\end{aligned}$$

Soil Loss = 50.1 t/ac
= 11.23 kg/m²

CLIENT FILE: BST95

BST95.W1

23005 USA TX BIG_SPRING modified for Big Spring Jan to May95 BST95.W1

32 14 N 101 30 W 784 19590507 19701231 AGA 95 91

5.32	5.82	6.24	7.30	6.95	6.80	5.97	5.52	5.68	5.93	5.83	5.70
2.11	1.98	1.86	2.32	2.83	2.68	2.82	2.61	2.47	2.26	2.15	2.12
1.17	1.15	1.13	1.10	1.09	1.08	1.07	1.08	1.09	1.11	1.14	1.16
247	45	247	225	180	180	180	180	180	180	180	225
1.3	1.5	1.2	1.0	2.1	5.1	3.7	1.6	3.5	3.6	2.1	1.5
0.70	0.56	0.71	0.79	0.86	0.93	0.96	0.85	0.75	0.80	0.64	0.60
9.0	6.5	3.3	1.7	1.7	3.8	4.0	4.7	6.1	7.2	7.8	9.5
16.3	18.7	21.0	26.6	29.0	33.7	34.7	34.2	30.6	25.7	19.0	15.3
1.0	2.8	6.4	10.2	15.0	19.5	21.6	20.9	17.3	11.4	4.5	0.4
-3.1	-1.3	-1.0	4.0	10.5	14.9	16.0	15.2	13.7	8.5	1.9	-1.6
287	329	413	544	621	844	845	766	668	527	411	357
15.2	13.5	14.2	42.4	25.1	49	47	45	67	42	16	14
11	5	10	4	4	4.6	4.8	5.0	5.5	4.5	2.9	2.7
0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
6.6	9	3.6	181	116	371	226	226	226	226	64	16
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

32 13 N 101 30 W 1.9 TX BIG SPRING WB AP

RWEQ INPUT FORM

CLIENT: BST95WEATHER FILE: BST95.W1MANAGEMENT FILE: BST95.MAN

Soil Properties: soil texture
sand 83.6 %
silt 8.4 %
organic matter 0.29 %
calcium carbonate - %
rock cover - %

Field Geometry: *shape circular or rectangular
*area 6.5 acres
*orientation - degrees from north
*length_N - feet
*slope gradient -
*slope length - feet

EF: 0.59SCF: 0.70Longitude 101° 29.19'Latitude 32° 16.21'Elevation 2690' (820m)Annual Rainfall 18.5" (470mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand	EF	K ⊥	K 	Sil	Ca	
									Spac.	Ht.	Orient.									
1/11/95	COTTON	0	4	0	NONE	PLANE	Y	0.1	0	0	0	Y	100	100	0.72	0.81				
3/10/95	COTTON	0	5	0	NONE	NONE	N	0	0	0	0	N	100	100	0.73	1.0				
4/10/95	COTTON	0	9	0	NONE	NONE	N	0	0	0	0	N	100	100	0.59	0.98				
5/8/95	COTTON	0		0	NONE	NONE	N	0	0	0	0	N	100	100	0.48					
5/15/95	COTTON	0	4	0	NONE	NONE	N	0	0	0	0	N	100	100	0.60	0.14				

Soil Loss = 174.7 t/ac= 39.15 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \underline{46.9} \text{ t/ac} \\ &= \underline{10.51} \text{ kg/m}^2\end{aligned}$$

$$\begin{aligned}\text{Soil Loss} &= \underline{53.5} \text{ t/ac} \\ &= \underline{11.99} \text{ kg/m}^2\end{aligned}$$

CLIENT FILE: TEXAS2

TX295.W1

23005 USA TX BIG_SPRING modified for TX2 (Louder) FEB-MAY 1995
 32 14 N 101 30 W 784 19590507 19701231 AGA 95 91
 5.91 5.28 5.82 6.29 6.09 5.75 4.28 4.71 3.84 4.83 4.49 4.64
 2.13 2.24 2.06 1.84 1.95 2.17 1.69 2.56 1.89 2.32 1.84 2.05
 1.17 1.15 1.13 1.10 1.09 1.08 1.07 1.08 1.09 1.11 1.14 1.16
 247 45 247 225 180 180 180 180 180 180 180 225
 1.3 1.5 1.2 1.0 2.1 5.1 3.7 1.6 3.5 3.6 2.1 1.5
 0.70 0.56 0.71 0.79 0.86 0.93 0.96 0.85 0.75 0.80 0.64 0.60
 8.0 21.1 15.3 12.3 7.2 10.7 21.8 24.1 23.6 25.3 21.7 21.0
 13.6 18.7 20.0 26.8 28.7 33.2 36.8 34.4 29.6 27.6 21.1 15.7
 -1.3 2.2 4.2 8.5 14.9 18.2 20.1 20.3 16.3 9.4 3.6 -1.2
 -3.1 -1.3 -1.0 4.0 10.5 14.9 16.0 15.2 13.7 8.5 1.9 -1.6
 378 204 245 347 337 385 386 331 252 262 189 150
 17 15 10 18 99 19 32 7 65 9.4 0 .5
 3.5 5 6 3 13 6 7 4 10 1 0 1
 0.7 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 2.5
 0 10 2.6 13.7 363 18 85 4 112 11.6 0 .02
 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
 32 13 N 101 30 W 1.9 TX BIG SPRING WB AP

RWEQ INPUT FORM

CLIENT: TEXAS2WEATHER FILE: TX295.W1MANAGEMENT FILE: TX295.MAN

Soil Properties: soil texture
 sand 43 %
 silt 42 %
 organic matter 0.8 %
 calcium carbonate 1.0 %
 rock cover - %

Field Geometry: *shape circular or rectangular
 *area 180 acres
 *orientation 0 degrees from north
 *length_N 2600 feet
 *slope gradient -
 *slope length - feet

EF: 0.47SCF: 0.40Longitude 101° 53.92'Latitude 32° 9.03'Elevation 2650 (803m)Annual Rainfall 16.5" (419mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand	EF	K ⊥	K ∥	Sil	Cu	
									Spac.	Ht.	Orient.									
1/24/95	NONE	0		0	NONE	MOLDB8	Y	1.9	0	0	0	N	5	0	0.51	0.10	0.44			
3/28/95	NONE	0		0	NONE	LISTER	Y	1.0	40	10	0	N	20	0	0.61	0.11	0.02			
5/17/95	NONE	0		0	NONE	ROD-PLA	Y	0.4	40	6	0	N	90	50	0.60	0.12	0.29			
6/6/95	NONE	0		0	NONE	PLAN-ROW	Y	0.4	40	6	0	N	90	50	0.56	0.11	0.44			

Soil Loss = 0.9 t/ac= 0.2 kg/m²

CLIENT FILE: PLAINSE

PT95.W1

#93034 USA NM HOBBS modified for Plains, TX (Bearden) NOV 94-JUN 95

32 41 N 103 12 W 1123 19950101 19950831 ARF 50 73

4.97	5.18	6.40	6.78	7.11	6.83	4.49	4.79	3.49	4.07	4.38	3.29
1.56	1.75	1.99	1.69	1.98	2.46	1.77	2.42	1.65	1.73	1.47	1.37
1.11	1.10	1.09	1.07	1.05	1.03	1.04	1.04	1.05	1.07	1.10	1.11
247	225	247	225	225	158	158	158	0	225	247	247
2.3	1.6	2.0	1.8	1.2	1.9	2.0	1.5	1.9	3.1	1.3	1.8
0.82	0.71	0.95	0.67	0.77	0.91	0.80	0.79	0.60	0.64	0.83	0.90
11.6	10.2	5.2	3.9	0.6	2.6	7.4	16.2	13.8	12.5	14.5	6.5
12.6	17.2	21.1	24.6	27.9	32.9	36.2	33.5	27.9	25.7	17.9	14.9
-1.3	1.3	4.2	5.9	12.9	16.1	18.5	17.8	14.3	6.7	3.3	0.2
-5.1	-3.9	-3.9	-0.4	4.9	10.5	14.1	13.5	10.8	5.7	-0.9	-3.4
250	332	435	532	512	653	637	578	426	436	285	234
21	13	2	15	58	68	1	62	212	0	16.8	1.5
4	2	2	2	8	7	2	3	12	0	6	3
4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.2
9.5	9.3	0.13	0.76	126	1012	.1	278	762	0	.1	.4
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

32 39 N 103 22 W 16.0 NM PEARL I

RWEQ INPUT FORM

CLIENT: PLAINSEWEATHER FILE: PT95.W1MANAGEMENT FILE: YETX95E.MAN

Soil Properties: soil texture
sand 76%
silt 16%
organic matter 3%
calcium carbonate 1%
rock cover -%

Field Geometry: *shape circular or rectangular
*area 160 acres
*orientation 0 degrees from north
*length_N 2640 feet
*slope gradient -
*slope length - feet

EF: 0.57SCF: 0.70Longitude 102° 41.5'Latitude 33° 11.2'Elevation 2825' (856m)Annual Rainfall 14" (356mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand	EF	K ⊥	K 	Sil	Can	
									Spac	Ht	Orient.									
11/15/94	COTTON	200		6	NONE	HARVEST	Y	0.1	40	3	0	Y	100	100						
12/6/94	COTTON	0	25	0	NONE	CHI-STR	Y	0.7	14	3	45	N	70	70	0.72	0.14		60		
4/6/95	COTTON	0		0	NONE	LISTER	Y	1.2	40	10	0	N	20	0		0.52				
4/29/95	COTTON	0		0	NONE	RDD-PLA	Y	0.6	40	7	0	N	90	50		0.52				
5/20/95	COTTON	0		0	COTTON	PLAN-ROW	Y	0.4	40	4	0	N	90	50	0.59					
6/3/95	COTTON	0		0	COTTON	RDD-PLA	Y	0.3	40	3	0	N	90	50						

Soil Loss = 8.1 t/ac
= 1.82 kg/m²

CLIENT FILE: PLAINSB

PT95.W1

#93034 USA NM HOBBS modified for Plains, TX (Bearden) NOV 94-JUN 95

32	41	N	103	12	W	1123	19950101	19950831	ARF	50	73	
4.97	5.18	6.40	6.78	7.11	6.83	4.49	4.79	3.49	4.07	4.38	3.29	
1.56	1.75	1.99	1.69	1.98	2.46	1.77	2.42	1.65	1.73	1.47	1.37	
1.11	1.10	1.09	1.07	1.05	1.03	1.04	1.04	1.05	1.07	1.10	1.11	
247	225	247	225	225	158	158	158	0	225	247	247	
2.3	1.6	2.0	1.8	1.2	1.9	2.0	1.5	1.9	3.1	1.3	1.8	
0.82	0.71	0.95	0.67	0.77	0.91	0.80	0.79	0.60	0.64	0.83	0.90	
11.6	10.2	5.2	3.9	0.6	2.6	7.4	16.2	13.8	12.5	14.5	6.5	
12.6	17.2	21.1	24.6	27.9	32.9	36.2	33.5	27.9	25.7	17.9	14.9	
-1.3	1.3	4.2	5.9	12.9	16.1	18.5	17.8	14.3	6.7	3.3	0.2	
-5.1	-3.9	-3.9	-0.4	4.9	10.5	14.1	13.5	10.8	5.7	-0.9	-3.4	
250	332	435	532	512	653	637	578	426	436	285	234	
21	13	2	15	58	68	1	62	212	0	16.8	1.5	
4	2	2	2	8	7	2	3	12	0	6	3	
4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	0.2	
9.5	9.3	0.13	0.76	126	1012	.1	278	762	0	.1	.4	
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
32	39	N	103	22	W	16.0	NM	PEARL I				

RWEO INPUT FORM

CLIENT: PLAINSB

WEATHER FILE: PT95.W1

MANAGEMENT FILE: YB TX 95B.MAN

Soil Properties: soil texture
sand
silt
organic matter
calcium carbonate
rock cover

Field Geometry:

*shape	circular or <u>rectangular</u>
*area	<u>320</u> , acres
*orientation	<u>0</u> , degrees from north
*length_N	<u>3400</u> , feet
*slope gradient	<u>-</u>
*slope length	<u>-</u> , feet

EF: 0.55
SCF: 0.40

Longitude $102^{\circ} 37.55'$

Latitude **33° 12.08**

Elevation 2825' (856m)

Annual Rainfall 14" (356mm)

[illegible]
$$\begin{aligned}\text{Soil Loss} &= \underline{1.6} \text{ t/ac} \\ &= \underline{.36} \text{ kg/m}^2\end{aligned}$$

CLIENT FILE: PTE96

PT96.W1

#93034 USA NM HOBBS modified for Plains, TX (Bearden) DEC 95 TO JUN 96

32 41 N 103 12 W 1123 19950101 19950831 ARF 50 73

5.76	5.16	6.42	6.80	6.43	4.15	3.47	3.38	3.23	4.28	4.78	4.44
1.83	1.53	1.97	2.15	2.31	1.55	1.91	2.06	1.72	1.95	1.98	1.92
1.11	1.10	1.09	1.07	1.05	1.03	1.04	1.04	1.05	1.07	1.10	1.11
247	225	247	225	225	158	158	158	0	225	247	247
2.3	1.6	2.0	1.8	1.2	1.9	2.0	1.5	1.9	3.1	1.3	1.8
0.82	0.71	0.95	0.67	0.77	0.91	0.80	0.79	0.60	0.64	0.83	0.90
9.2	8.3	8.3	4.8	3.4	6.7	15.0	16.3	19.7	13.4	14.2	16.2
14.2	17.7	19.0	25.8	34.8	34.3	33.8	31.7	28.4	24.5	18.3	14.1
-4.0	-1.1	-1.6	5.5	14.7	17.9	19.0	18.0	13.1	7.0	1.1	-2.3
-5.1	-3.9	-3.9	-0.4	4.9	10.5	14.1	13.5	10.8	5.7	-0.9	-3.4
302	364	500	604	643	632	565	513	480	363	299	250
3	0	0.3	10.4	27.9	65.8	42.4	144.8	31.8	7.9	8.9	3
1	0	1	2	3	12	9	9	6	2	4	3
4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.7
1.0	0.0	0.0	5.5	77.1	192.4	48.5	1181	29.5	4.0	1.8	.4
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

32 39 N 103 22 W 16.0 NM PEARL I

RWEQ INPUT FORM

CLIENT: PTE96WEATHER FILE: PT96.W1MANAGEMENT FILE: PTE96.MAN

Soil Properties: soil texture
sand 76%
silt 16%
organic matter 0.3%
calcium carbonate 1.0%
rock cover -%

Field Geometry: *shape circular or rectangular
*area 160 acres
*orientation 10 degrees from north
*length_N 2640 feet
*slope gradient -
*slope length - feet

EF: 0.57SCF: 0.70Longitude 102° 41.5'Latitude 33° 11.2'Elevation 2825' (856m)Annual Rainfall 14" (356mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand	EF	K I	K II	Sil	Can	
									Spac	Ht.	Orient.									
12/12/95	COTTON	400	14	6	NONE	HARVEST	Y	0.1	48	6	0	Y	100	100	0.75	0.15	0.88			
2/14/96	COTTON	0		0	NONE	CHIS-STR	Y	0.9	12	2	0	N	70	70		0.17	0.88			
2/22/96	COTTON	0		0	NONE	MOLDB	Y	1.9	0	0	0	N	5	0	0.59	0.20	0.29			
5/7/96	COTTON	0		0	NONE	LISTER	Y	1.0	48	9	90	N	20	0		0.05				
6/4/96	COTTON	0		0	COTTON	PLAN-ROW	Y	0.4	48	6	90	N	90	50	0.69	0.04				

Soil Loss = 2.7 t/ac
= .61 kg/m²

Soil Loss = 1.0 t/ac
= 0.22 kg/m²

CLIENT FILE: PTX96B16

PT96.W1

#93034 USA NM HOBBS modified for Plains, TX (Bearden) DEC 95 TO JUN 96

32 41 N 103 12 W 1123 19950101 19950831 ARF 50 73

5.76	5.16	6.42	6.80	6.43	4.15	3.47	3.38	3.23	4.28	4.78	4.44
1.83	1.53	1.97	2.15	2.31	1.55	1.91	2.06	1.72	1.95	1.98	1.92
1.11	1.10	1.09	1.07	1.05	1.03	1.04	1.04	1.05	1.07	1.10	1.11
247	225	247	225	225	158	158	158	0	225	247	247
2.3	1.6	2.0	1.8	1.2	1.9	2.0	1.5	1.9	3.1	1.3	1.8
0.82	0.71	0.95	0.67	0.77	0.91	0.80	0.79	0.60	0.64	0.83	0.90
9.2	8.3	8.3	4.8	3.4	6.7	15.0	16.3	19.7	13.4	14.2	16.2
14.2	17.7	19.0	25.8	34.8	34.3	33.8	31.7	28.4	24.5	18.3	14.1
-4.0	-1.1	-1.6	5.5	14.7	17.9	19.0	18.0	13.1	7.0	1.1	-2.3
-5.1	-3.9	-3.9	-0.4	4.9	10.5	14.1	13.5	10.8	5.7	-0.9	-3.4
302	364	500	604	643	632	565	513	480	363	299	250
3	0	0.3	10.4	27.9	65.8	42.4	144.8	31.8	7.9	8.9	3
1	0	1	2	3	12	9	9	6	2	4	3
4.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	4.7
1.0	0.0	0.0	5.5	77.1	192.4	48.5	1181	29.5	4.0	1.8	.4
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

32 39 N 103 22 W 16.0 NM PEARL I

RWEQ INPUT FORM

CLIENT: PTX96B16WEATHER FILE: PT96.W1MANAGEMENT FILE: PTX96B16.MAN

Soil Properties: soil texture
sand 81 %
silt 4 %
organic matter 0.2 %
calcium carbonate 1.0 %
rock cover - %

Field Geometry: *shape circular or rectangular
*area 320 acres
*orientation 90 degrees from north
*length_N 3600 feet
*slope gradient -
*slope length - feet

EF: 0.55SCF: 0.40Longitude 102° 37.55'Latitude 33° 12.08'Elevation 2825' (856m)Annual Rainfall 14" (356mm)

DATE	VEGETATION					OPERATION / EVENT										SOIL			CROP	
	Residue	Yield	% Cov.	# Stems	Growing Crop	Implement	Mod. Rough.	RR	-----Ridge-----			Kill Crop	% Flat	% Stand.	EF	K ⊥	K 	Sil	Can	
									Spac.	Ht.	Orient.									
12/13/95	SORGHUM	1000		5	NONE	HARVEST	Y	0.1	40	2	90	Y	100	100	0.82	0.23	0.88			
2/22/96	SORGHUM	0		0	NONE	LISTER	Y	0.1	40	8	90	N	20	0	0.53	0.18	0.36			
5/29/96	SORGHUM	0		0	NONE	NONE	N	0	0	0	0	N	100	100	0.65	0.06				

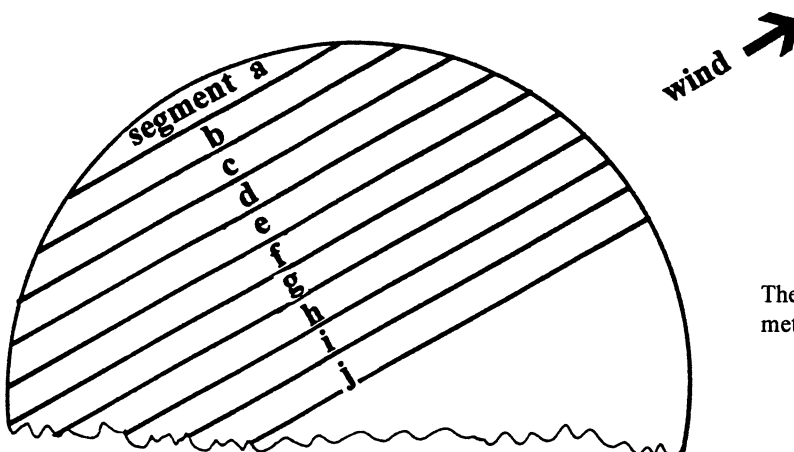
Soil Loss = 2.4 t/ac
= .54 kg/m²

$$\begin{aligned}\text{Soil Loss} &= \underline{13.3} \text{ t/ac} \\ &= \underline{2.98} \text{ kg/m}^2\end{aligned}$$

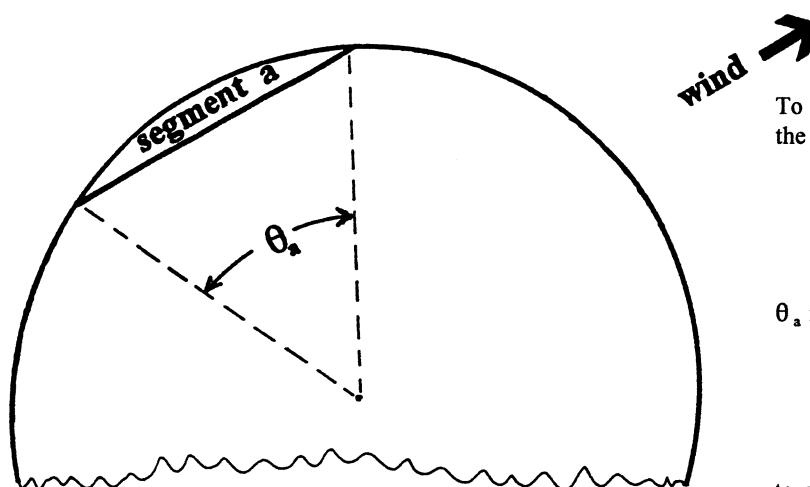
Soil Loss = .6 t/ac
= .13 kg/m²

Soil Loss = 4.7 t/ac
= 1.05 kg/m²

APPENDIX L-1



The 100 meter radius circle is divided into 10 meter width strips.



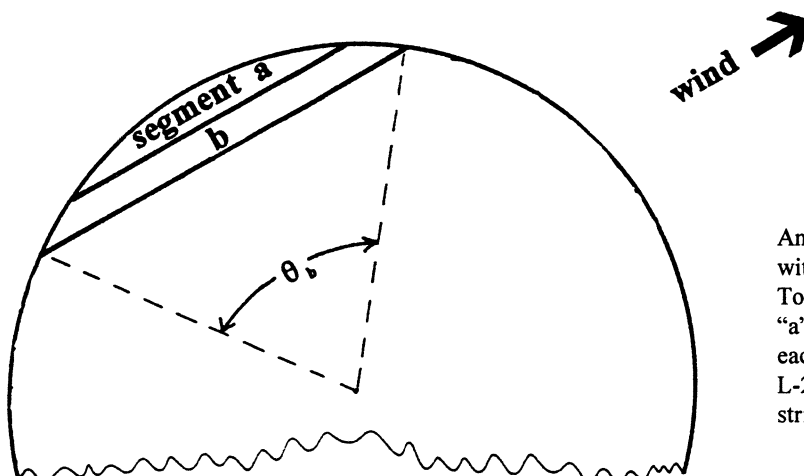
To calculate the area for strip "a" first calculate the angle θ_a . Using

$$\cos \frac{1}{2} \theta_a = \frac{r - 10}{r} = 0.9$$

θ_a is 51.7° . Then use

$$S_a = \frac{\pi r^2 \theta_a}{360} - \frac{r^2 \sin \theta_a}{2}$$

to compute total segment area "a". The equivalent length of the 10-meter wide strip is 58.8 meters.



Angle θ_b is 73.7° . Using the above equation with θ_b gives the area of segments "a" and "b". To get the area of segment "b" subtract area "a" from the segment area "a+b". Calculate each strip (a-j) in a similar manner. Appendix L-2 gives the details of the calculations for strips a through j.

APPENDIX L-2

Segment	θ <i>degrees</i>	Multiplier ¹	Total Area of segment <i>meters</i> ²	Area of strip only <i>meters</i> ²	Length of 10-meter strip <i>meters</i>
a	51.7	0.05878	587.8	587.8	58.8
b	73.7	0.16325	1632.5	1044.7	104.5
c	91.1	0.29509	2950.9	1318.4	131.8
d	106.3	0.44774	4477.4	1526.5	152.7
e	120.0	0.61419	6141.9	1664.5	166.5
f	132.8	0.79204	7920.4	1778.5	177.9
g	145.1	0.98017	9801.7	1881.3	188.1
h	156.9	1.17305	11730.5	1928.8	192.9
i	168.5	1.37076	13707.6	1977.1	197.7
j	180.0	1.57080	15708.0	2000.4	200.0

¹ Values in this table are based on a radius of 100 meters. The multiplier is given to facilitate calculations for circles with different radii. To determine the area for a segment in a circle with a radius of “x” multiply the “multiplier” times “x”.

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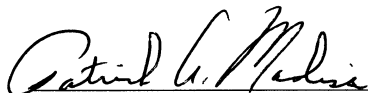
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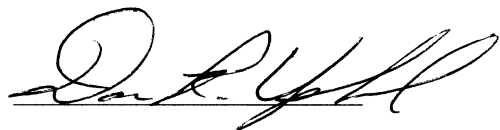
Patrick A. Madison
President

Date:

6/4/98

USDA

By:



Dan R. Upchurch
Research Leader

Date

6/3/98

SOIL SURFACE ROUGHNESS DECAY
BY RAINFALL AMOUNT AND EROSIVITY INDEX (EI)

ALI SALEH¹

DRAFT

Submitted to *Soil Science*

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ABSTRACT

Rainfall amount erosivity index (EI) decay soil aggregates and ridges at different rates. To evaluate the decay of soil aggregates and ridges by natural rainfall amount and EI. Field and rainfall simulator experiments were conducted. One half of a field with fine sandy loam soil, located in West Texas, was tilled with a lister; the other half, with a moldboard plow. Soil surface roughness was measured before and after each rain event. About 500 mm of rainfall (EI = 3113 MJ-mm/ha-hr) melted the soil aggregates completely; whereas, ridges decayed only 58% after 678 mm of rainfall (EI = 4787 MJ-mm/ha-hr). Equations were developed to estimate decay of soil aggregates and ridges from rainfall amount and EI. Because only one soil was used during the field experiment, these equations are not applicable to other soil types. Therefore, a soil roughness decay factor (DF) was developed from rainfall simulator experiments. Aggregates of 16 soils, ranging from fine sandy loam to clay (including the soil used in the field experiment) were irrigated at the same rate and intensity by a rainfall simulator. Soil aggregate roughness was measured before and after simulated rainfall. DF was obtained by computing the ratio of the decay rate of aggregates of 15 soils to that of the field study soil. DF was used to modify the predictive equations for other soils. These modified equations estimating soil aggregate decay were tested by two data sets from the literature.

INTRODUCTION

Soil surface roughness, including ridges (oriented roughness, OR) and aggregates (random roughness, RR) significantly affects wind and water erosion. For instance, soil surface roughness affects soil particle emission and trapping during a wind erosion event (Hagen, 1988). It also reduces the runoff velocity and thus decreases soil detachment and transport (Cogo *et al.*, 1983) caused by water erosion.

Soil surface roughness changes considerably with rain, wind, freezing and thawing, and cultivation (Zobeck and Onstad, 1987). Onstad *et al.* (1984) and Römken and Wang (1985) described the soil aggregate decay as a function of cumulated rainfall.

Potter (1990a) developed an exponential function to predict soil aggregate decay as a function of cumulated rainfall. He related the coefficients in this function to the soil organic carbon and clay content. He concluded that soil aggregate stability increased with the percent clay content up to 31% and then decreased with additional clay.

Other researchers found the need to replace the rainfall amount with a more sensitive variable that would express the rainfall energy. Dexter (1977), Johnson *et al.* (1979), Steichen (1984), and Mannering *et al.* (1966) found a strong relationship between rainfall kinetic energy and soil aggregate decay.

Different techniques are used to measure soil surface roughness. Allmaras *et al.* (1966) developed a random roughness index (RR) to characterize soil surface roughness due to aggregates.

RR is based on the standard error of the adjusted natural log transformed surface elevation. Before computation of this index, the effects of slope and oriented roughness (OR) are removed.

Potter *et al.* (1990) developed a microrelief index based on the shelter angle concept. Shelter angle is defined as the maximum angle from the horizontal between measured elevation points within a 0.3-m distance on the soil surface. They calculated shelter angles for 800 points within a 1-m² area and determined their cumulative distribution as an index of surface roughness (known as Cumulative Shelter Angle Distribution, CSAD).

Potter and Zobeck (1990) fitted the Weibull function (Johnson and Kutz, 1970) to the CSAD as follows:

$$F = 1 - e^{\left(-\frac{S}{B}\right)^C} \quad (1)$$

where

- F = cumulative fraction of the surface
- S = shelter angle, degrees
- B and C = regression coefficients determined by non-linear least squares fit.

The B coefficient, or scale factor, increases with greater roughness and may be used as a soil surface roughness index.

Saleh (1993) developed a simple but efficient method to measure soil surface roughness using a high speed roller chain. This method is based on the principle that when a chain of given length (L1) is placed across a surface, the horizontal distance between chain ends (L2) decreases as the roughness increases. Soil surface roughness (C_r) is calculated using the L2/L1 ratio as follows:

$$C_r = \left(1 - \frac{L2}{L1}\right) \times 100 \quad (2)$$

The past studies on soil surface roughness decay are limited to soil aggregates. Generally the decay rate obtained for aggregates has been used for ridges; however, field observations indicate that ridges decay at a totally different rate than that of aggregates. Therefore, a different set of equations describing the decay of ridges is needed.

Decay of surface roughness has been studied using rainfall simulators. Most simulated rain storms have a linear kinetic energy/ rainfall intensity relationship while such relationships from natural rainstorms are non-linear. Therefore, a roughness decay study under natural rainfall is needed.

This study was conducted to develop predictive equations to estimate soil aggregate and ridge decay from rainfall amount and storm erosivity and soil properties.

METHODS AND MATERIALS

Field Preparation:

The field study was conducted from January through September, 1992 on an Amarillo fine sandy loam located in Howard County, Texas (Table 1, soil #1).

Half of the field was bedded with a lister which created 0.3-m high ridges with 1-m spacing and medium-to-large size aggregates (less than 0.12 m in diameter). The other half of the field was moldboard plowed which created a surface with no profound ridges but with large aggregates (less than 0.2 m in diameter).

Field Soil Surface Roughness Measurement:

Soil surface elevation was measured after each tillage operation and after each rainfall of at least 20 mm using a pin-type soil microrelief meter (20 rows, 50 mm apart by 40 pins/row, 25 mm apart to give a grid of 800 surface elevations). The measurements were made along a 1-m transect perpendicular to the tillage direction. There were 3 sets of height readings (800/m²) for the listed portion and 3 sets for the plowed portion of the field.

Soil surface elevations were corrected for slope and were then used to calculate the Weibull scale factor, B (Potter *et al.* 1990). The coefficient B which was calculated from measurements perpendicular to the ridges was due to ridges and aggregates and expressed as oriented roughness (B_{per}). The coefficient B which was calculated from measurements parallel to the ridges was due to aggregates and expressed as B_{par} .

Field Rainfall measurement:

Rainfall amount was recorded every 10 minutes by a rainfall gauge connected to a data logger. Equations (3) - (6) from Wischmeier and Smith (1958) and Foster *et al.* (1981) were used to calculate storm erosivity for each rainfall event using 10 minute rainfall data.

$$EI = (E * I_{30}) \quad (3)$$

where

- EI = storm erosivity, $MJ-mm-ha^{-1}-hr^{-1}$
- I_{30} = maximum 30-min rainfall intensity, mm/hr
- E = total storm kinetic energy, $MJ-ha^{-1}$, which is obtained by:

$$E = \sum_{k=1}^n E_r \Delta V_r \quad (4)$$

where

- n = number of 10-minute rainfall intervals
- ΔV_r = rainfall amount during 10-minute interval, mm
- E_r = rainfall energy, $MJ-ha^{-1}-mm^{-1}$, for each 10-minute rainfall interval which is computed from the following equations.

$$E_r = 0.119 + 0.0873 \log_{10}(i_r) \quad (5)$$

$$i_r \leq 76 \text{ mm-hr}^{-1} \quad .$$

$$E_r = 0.283 \quad (6)$$

$$i_r > 76 \text{ mm-hr}^{-1} \quad .$$

I_{30} was obtained by selecting the highest 30-minute intensity during the storm event.

Rainfall Simulator Experiments:

Soil aggregates (less than 0.1 m in diameter) were collected from 16 sites including the field study site. Soils ranged from fine sandy loam to clay (Table 1) and organic matter content varied from 0.41 to 3.27 percent. Particle size distribution was measured by the pipette method (Day, 1965). Organic carbon was determined by the chromic oxidation method (Peech *et al.*, 1947). Soil aggregates for each soil were placed randomly on three 0.2 by 0.5-m porous trays. A total of 41.7 mm of water was applied to each tray at the rate of 27.8 mm hr⁻¹ with an average kinetic energy of 25.0 J m² mm⁻¹ during three simulated rainfall events. The soil aggregate roughness was measured by the chain method (Saleh, 1993) before and after each rainfall event.

1. A 0.01 m linked roller chain (ANSI 35 riv. type) with a length of 1 meter (L1 = 1 m) was very carefully laid on the top of aggregates.
2. A caliper rod was used to read the linear distance (L2).
3. Equation (2) was used to calculate C_r caused by random roughness (C_{rr}).

RESULTS AND DISCUSSION

Field Study:

Tables 2 and 3 show the summary of data obtained from the field experiment. Average annual rainfall at this study site is 487 mm. However, during this study about 678 mm of rainfall was recorded. The ratio of calculated EI per unit of rainfall increased from 0.62 in January to 11.5 in June, indicating more intense rainfall during the warmer season (Table 2).

Smaller aggregates in the listed field decayed at a slightly higher rate than that of the moldboard plowed field. Soil surface aggregates of both fields decayed after 500 mm of rainfall.

Equation (7) was obtained from regressing the natural log of RRR (B_{par} after rainfall / initial B_{par}) (average of three replications) and cumulated EI (CUMEI, Mj-mm/ha-hr) for both tillage treatments (Table 3, Fig. 1):

$$RRR = e^{[-0.0012 CUMEI]} \quad (7)$$

$$R^2 = 0.94, P < 0.001 \quad .$$

A similar but less significant relationship was obtained between natural log of RRR and cumulated rainfall (CUMR, mm) ($R^2 = 0.71$, $P < 0.001$) (Table 3, Fig. 2):

$$RRR = e^{[-0.005 CUMR]} \quad (8)$$

$$R^2 = 0.71, P < 0.001 \quad .$$

Comparing equation (8) to equation (7) indicates that CUMR did not describe the change in B_{par} during the first part of season as well as CUMEI (Figs. 1 and 2). Because of lower intensity rainfall during the early season (January through March) soil aggregate decay per unit of rainfall was much lower than later in the season (Fig. 2). Consequently, if only the rainfall amount was used as the driving parameter for soil aggregate decay, the decay rate for low intensity rainfall might be over-estimated.

CUMEI and CUMR had similar effects on ridge decay (ORR)(Table 2, Figs. 3 and 4). Figures 1 and 2 show that RR had decayed completely for both sections of the field by 3113 units of EI (500 mm of rainfall) while 48% of OR in the listed field remained after the total of 4787 units of EI (710 mm of rainfall) (Figs. 3 and 4). Because of the lower decay rate, ridges perpendicular to erosive wind would be better than aggregates to reduce erosion when surface roughness is used for erosion control, especially for high rainfall and irrigated lands. The first 25% of B_{per} decayed at almost an equivalent rate to the decay rate of the first 25% of B_{par} then the B_{per} decay rate decreased significantly. This was because of the rapid decay of aggregates covering the ridges. After aggregates dissipated, ridges became very stable and decayed at a slower rate.

Equations (9) and (10) were obtained by regressing the natural log of ORR (B_{per} after rainfall / initial B_{per}) on CUMEI or CUMR, respectively.

$$ORR = e^{[-0.05 CUMEI^{0.31}]} \quad (9)$$

$$R^2 = 0.99, P < 0.01 \quad .$$

$$ORR = e^{[-0.017 CUMR^{0.567}]} \quad (10)$$

$$R^2 = 0.98, P < 0.01 \quad .$$

In some parts of the United States (*e.g.* Northwest) rain falls with low intensity, whereas in other parts (*e.g.* Southeast) rainfall intensity occurs at much higher rate. To capture the effect of both rainfall amount and intensity, equation (11) was obtained from the regression of RRR on CUMEI and CUMR.

$$RRR = e^{[-0.0009 CUMEI - 0.0007 CUMR]} \quad (11)$$

$$R^2 = 0.95, P < 0.01 \quad .$$

Equation (12) was obtained when the natural log of ORR was regressed on CUMEI and CUMR.

$$ORR = e^{[-0.025 CUMEI^{0.31} - 0.0085 CUMR^{0.567}]} \quad (12)$$

$$R^2 = 0.99, P < 0.01 \quad .$$

Rainfall Simulator Study:

Application of the equations (11) and (12) is limited to those soils similar to the soil in the field study. To use these equations for other soils, the roughness decay factor (DF) was obtained by computing the ratio of RRR from soils #2 through #16 (Table 1) to that of soil #1 (field study soil). DF indicated that the soil aggregate stability was strongly related to clay and OM content (Fig. 5). For soils with less clay and OM than that of soil #1, DF was greater than 1.0 and for soils with higher clay and OM, DF was less than 1.0. The following function was fit to DF using the clay and OM content of tested soils as independent variables (Fig. 5).

$$DF = e^{[0.943 - 0.07 CLAY + 0.0011 CLAY^2 - 0.674 OM + 0.12 OM]} \quad (13)$$

$$R^2 = 0.92, P < 0.01$$

where

CLAY = clay content, %

OM = organic matter, %.

Soil aggregate stability increased with clay content to 32% and organic matter to 2.7% and then decreased with greater amounts of clay or organic matter (Fig. 5). Potter (1990a) found similar results. Soil aggregates with higher clay content (*e.g.* soil #16) broke down as rapidly as sandy soils. Soil aggregates with low clay content (*e.g.* soil #2) broke down to erodible size particles (less than 0.001 m) whereas aggregates with higher clay content broke down to larger (less than 0.02 m), more stable aggregates.

In order to use equations (11) and (12) for other soil types, DF was inserted in these equations as follows:

$$RRR = e^{[DF (-0.0009 CUMEI - 0.0007 CUMR)]} \quad (14)$$

$$ORR = e^{[DF (-0.025 CUMEI^{0.31} - 0.0085 CUMR^{0.567})]} \quad (15)$$

In equations (14) and (15) DF affects the rate that RRR and ORR change based on soil clay, organic matter content, rainfall amount, and rainfall erosivity index.

Validation:

Two sets of data from the literature were selected to test equations (11) and (14) predicting soil aggregates decay.

Gilly and Kottwitz (1995) conducted a rainfall simulator study on a Sharpsburg soil (Fine, montmorillonitic, mesic Typic Agriudolls). Sand, silt, clay, and organic matter of this soil were approximately 5, 55, 40 and 1.89% respectively. Six tillage treatments provided a range of surface roughness conditions (Table 4). Simulated rainfall amounts of 35, 75, 150, and 300 mm were applied at 25 mm hr⁻¹ with an average kinetic energy of 27.5 J m⁻² mm⁻¹ over two consecutive days. Surface elevations were measured and random roughness (RR) was calculated by the Allmaras *et al.* (1966) method. The rainfall information was used to calculate EI (Table 4). DF by equation (13) for the Sharpsburg soil was 0.39. Table 4 and Fig. 6 show that the RR predicted by equation (14) and those measured by Gilly and Kottwitz (1995) are close (R² = 0.93, P<0.001). However, RR predicted by equation (11), without DF, did not match as well (R² = 0.75, P<0.001) (Table 4 and Fig. 6). This is because of the higher clay and OM contents in the Sharpsburg soil than in the soil used during the field study. Therefore equation (11) over-estimated the RR decay for this soil, and once DF was included (Eq. 14) the RR prediction improved significantly.

Potter (1990b) measured soil surface random roughness of five soils before and after simulated rainfall (5 to 80 mm). Simulated rainfall was applied at 58 mm/hr with an average kinetic energy of 27.5 J m⁻² mm⁻¹ for the time required to apply 5, 10, 20, 40, and 80 mm of water. The rainfall information from Potter (1990b) was used to calculate EI (Table 5). Surface microrelief was measured and used to calculate RR using the Allmaras *et al.* (1966) method. Predicted RR values by equation (14) and those measured by Potter (1990b) matched reasonably well (R² = 0.85, P < 0.001) (Table 5 and Fig. 7). However, once again the predicted RR from equation (11) without the DF factor resulted in under or over estimating RR for soils with a different clay or OM content.

Differences among predicted RR and RR measured by Gilly and Kottwitz (1995) and Potter (1990b) could be due to roughness measurement techniques. They used the Allmaras *et al.* (1966) method to express RR, whereas in this study random roughness was described as the Weibull coefficient B and C_r (obtained from the chain method). Nevertheless, comparisons show that equation (14) was capable of predicting RR after rainfall for different soils and aggregates of various sizes.

Because of lack of data available in the literature on ridge decay, a cooperative study is in progress to obtain field data to test equations predicting ORR.

SUMMARY AND CONCLUSIONS

Rainfall amount and EI cause soil aggregates and ridges to decay at different rates. This study was conducted to evaluate the decay of soil aggregates and ridges by natural rainfall amount and EI. This study included field and rainfall simulator experiments. During the field experiment a fine sandy loam soil, located in West Texas, was tilled by two tillage implements (a lister and moldboard plow). Soil surface roughness was measured before and after each rainfall event.

The field study showed that computed EI per mm of rainfall increased from 0.62 in January to 11.5 in June, indicating changes in rainfall characteristics throughout the year. Rainfall erosivity index (EI) was a better predictor of soil aggregate decay than rainfall amount. However, ridges with aggregates decayed at similar rates by either EI or rainfall amount. Soil aggregates decayed more rapidly than ridges. Thus, ridges are superior to aggregates for controlling erosion over extended period, especially for high rainfall and irrigated lands. Equations were obtained to predict soil aggregate and ridge decay from CUMEI or/and CUMR for the soil used during the field study; however, these equations were not applicable to other soils. Therefore, the decay factor (DF) was developed during the rainfall simulator study based on aggregates of 16 soils (ranging from fine sandy loam to clay) to modify the predictive equations obtained from field study for other soil types. The equations estimating the decay of soil aggregates were tested by data obtained from Gilly and Kottwitz (1995) and Potter (1990b) studies. Predicted RR values by equation (14) and those measured by Gilly and Kottwitz (1995) and Potter (1990b) matched reasonably well ($R^2 = 0.93$ and 0.85 respectively, $P < 0.001$). However, the predicted RR from equation (11) (without DF factor) resulted in under- or over-estimating RR for soils with different clay or OM content.

Because of lack of available data on ridges decay, equations regarding decay of ridges were not tested. Currently a cooperative study is in progress to obtain field data to test equations predicting ridge roughness decay.

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Table 1. Properties of tested soils.

Soil Number	Soil Series	Sand %	Silt %	Clay %	Organic matter %
1	Amarillo fine sandy loam	75.8	12.6	11.6	0.52
2	Amarillo loamy fine sand	79.8	12.2	8.0	0.41
3	Parshal fine sandy loam	62.6	25.6	11.8	1.70
4	Amarillo fine sandy loam	80.0	7.0	13.0	0.29
5	Amarillo sandy loam	71.0	14.8	14.2	1.07
6	Amarillo sandy loam	68.4	15.6	16.0	0.73
7	Haver loam	34.9	45.1	20.0	1.99
8	Temvik Wilon silt loam	26.3	53.7	20.0	3.27
9	Weld loam	36.0	42.0	22.0	1.08
10	Olton sandy clay loam	54.7	21.3	24.0	2.44
11	Olton sandy clay loam	48.7	28.0	25.3	1.13
12	Pullman loam	23.9	52.0	24.0	1.89
13	Sherm clay loam	34.5	37.8	27.7	1.45
14	Acuff sandy clay loam	49.6	21.5	28.9	1.25
15	Haney clay	18.7	32.0	49.3	1.90
16	Huston Black clay	4.8	39.0	56.2	2.10

Table 2. Monthly rainfall characteristics during the study.

Month	Rainfall <i>mm</i>	EI <i>Mj-mm/ha-hr</i>	EI/Rainfall
January	39.1	24.2	0.62
February	90.2	182.7	2.03
March	6.3	5.1	0.8
April	45.2	56.5	1.25
May	204.8	1310.1	6.4
June	133.6	1541.2	11.5
July	32.3	193.3	5.99
August	158.9	1408.1	8.85

Table 3. Data summary of field experiment.

DATE	CUMR <i>mm</i>	CUMEI <i>Mj-mm/ha-hr</i>	-----Listed-----						-----Plowed-----		
			B _{per}	SDV	B _{par}	SDV	RRR <i>fraction*</i>	ORR <i>fraction*</i>	B _{per}	SDV	RRR
01-10-92	0	0	34.48 [†]	4.90	11.35 [‡]	1.51	-	-	13.31 [†]	0.67	-
01-24-92	19.3	16.9	30.03	2.52	10.15	0.58	0.89	0.87	12.05	0.69	0.91
03-02-92	127.0	206.9	27.29	0.74	8.38	0.15	0.74	0.79	11.44	1.19	0.86
04-13-92	176.6	268.6	25.99	0.75	6.64	0.57	0.56	0.75	10.43	1.44	0.76
06-05-92	384.3	1578.5	20.79	1.32	2.01	0.46	0.18	0.60	3.15	1.70	0.22
06-16-92	504.6	3113.5	18.72	1.42	0	0	0	0.54	0	0	0
08-07-92	561.8	3378.8	19.21	1.72	0	0	0	0.55	0	0	0
08-17-92	616.1	3977.1	19.06	1.68	0	0	0	0.55	0	0	0
08-28-92	662.4	4304.8	17.98	1.20	0	0	0	0.52	0	0	0
09-08-92	709.4	4786.9	16.70	1.18	0	0	0	0.48	0	0	0

[†] Initial B_{per} (perpendicular)

[‡] Initial B_{par} (parallel)

* Fraction of roughness on 01-10-92

Table 4. Measured random roughness decay by Gilly and Kottwitz (1995) and predicted by equations (11) and (14).

Tillage Operation	CUMR <i>mm</i>	CUMEI <i>Mj-mm/ha-hr</i>	Measured RR <i>mm</i> †	Predicted RR (Eq. 11) <i>mm</i>	Predicted RR (Eq. 14) <i>mm</i>
Anhydrous Ammonia	0	0	7.5		
	35	240	7.6	5.9	6.7
	75	516	5	4.5	6.2
	150	1031	5.7	2.7	5.1
	300	2062	2.8	1.0	3.4
Chisel Plow	0	0	23.6		
	35	240	14.2	18.4	21.5
	75	516	12.4	14.2	19.4
	150	1031	10.8	8.5	15.8
	300	2062	8.8	3.1	10.6
Disk	0	0	14.3		
	35	240	10.8	11.2	13.1
	75	516	10.5	5.6	11.8
	150	1031	9.8	5.2	9.6
	300	2062	6.5	1.9	6.5
Field Cultivator	0	0	9.9		
	35	240	9.1	7.7	9
	75	516	5.8	5.9	8.1
	150	1031	5.1	3.6	6.6
	300	2062	3.5	1.3	4.5
Moldboard Plow	0	0	34.2		
	35	240	26.3	24.3	31.1
	75	516	23.9	20.5	26.0
	150	1031	22.2	12.3	22.8
	300	2062	15.6	4.5	15.4
Planter	0	0	5.6		
	35	240	4.4	4.4	5.1
	75	516	3.2	3.4	4.8
	150	1031	4.2	2.0	3.7
	300	2062	4.0	0.6	2.5

† Average of two replications.

Table 5. Measured random roughness decay by Potter (1990b) and predicted by equations (11) and (14).

Soil	Cumulated Rain <i>mm</i>	Cumulated EI <i>Mj-mm/ha-hr</i>	Measured RR <i>mm</i>	SDV	Predicted RR (Eq. 11) <i>mm</i>	Predicted RR (Eq. 14) <i>mm</i>
Amarillo LFS Clay = 8% OM = 0.34% DF = 1.27 †	0	0	23.3	4.4		
	5	67	19.5	5.2	22	21.7
	10	134	16.1	2.9	20.5	19.8
	20	268	14.6	2.9	18.2	17
	40	536	9.3	1.5	14.2	12.4
	80	1072	no data	no data	8.5	6.5
Amarillo FSL Clay = 15% OM = 0.47 DF = 0.86 †	0	0	31.2	5.7		
	5	67	28.7	7.3	29.3	29.6
	10	134	25.6	6.4	27.2	27.8
	20	268	24.6	2.3	24.5	25.3
	40	536	20.5	3.6	18.9	20.3
	80	1072	19.1	4.5	11.7	13.4
Acuff FSL Clay = 19% OM = 0.86% DF = 0.61 †	0	0	26.4	2.7		
	5	67	24.6	2.1	24.6	25.3
	10	134	27.3	3.6	24	24.9
	20	268	19.6	1.4	20.6	22.7
	40	536	16.4	1.9	16.1	19.5
	80	1072	15.3	0.7	9.9	14.5
Portales FSL Clay = 13% OM = 0.57% DF = 0.88 †	0	0	12.7	1.8		
	5	67	8.4	1.5	11.8	11.9
	10	134	9.6	1.5	11.1	11.3
	20	268	6.8	1.6	9.9	10.2
	40	536	8.0	2.2	7.4	8.2
	80	1072	6.2	1.0	4.7	5.3
Roscoe C Clay = 52% OM = 2.16% DF = 0.52 †	0	0	31.8	9.5		
	5	67	31.2	1.1	29.9	30.8
	10	134	24.2	5.3	27.7	29.6
	20	268	20.9	7.4	24	27.5
	40	536	29.4	1.2	19.6	24.5
	80	1072	20.3	7.4	11.6	18.8

† DF is calculated using equation 13.

Figure 1. B_{par} after/initial B_{par} ratio (RRR) as related to cumulative EI (CUMEI).

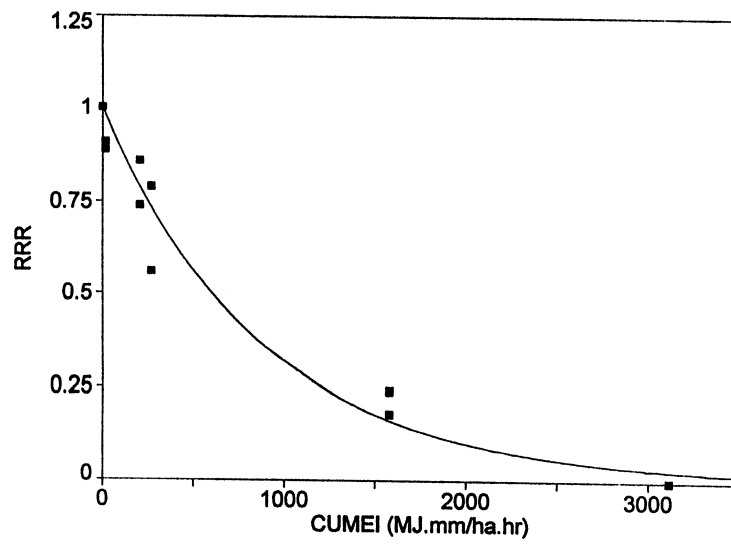


Figure 2. B_{par} after/initial B_{par} ratio (RRR) as related to cumulative rainfall (CUMR).

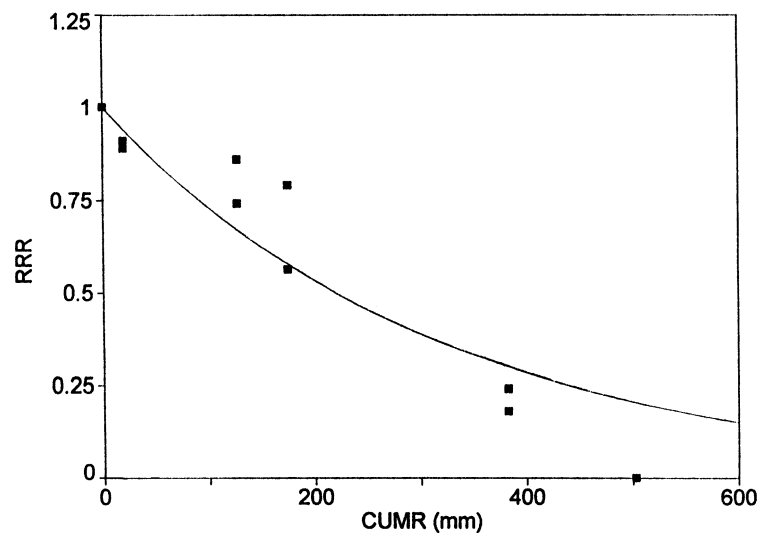


Figure 3. B_{per} after/initial B_{per} ratio (ORR) as related to cumulative EI (CUMEI).

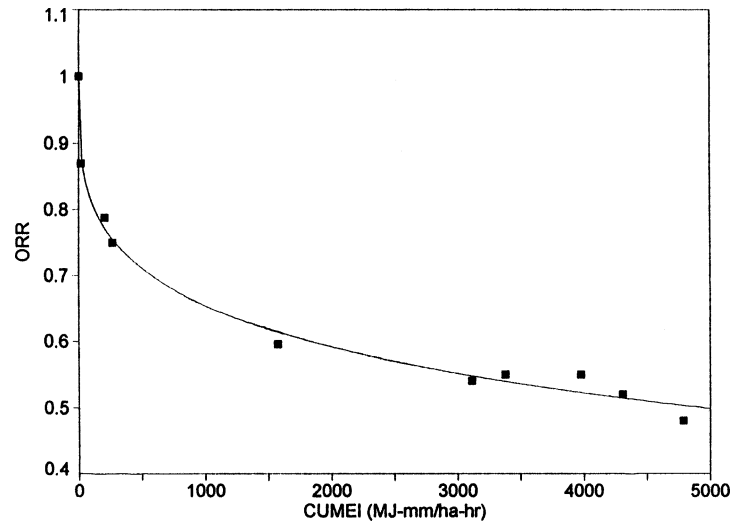


Figure 4. B_{per} after/initial B_{per} ratio (ORR) as related to cumulative rainfall (CUMR).

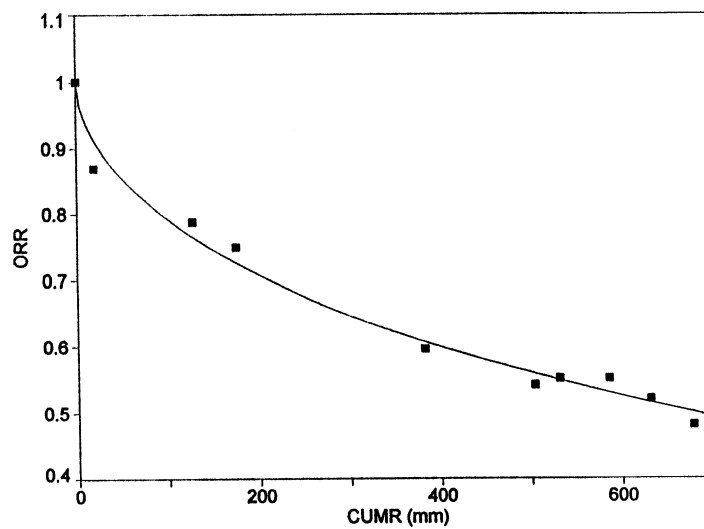


Figure 5. Decay factor (DF) as related to soil, clay, and organic matter content.

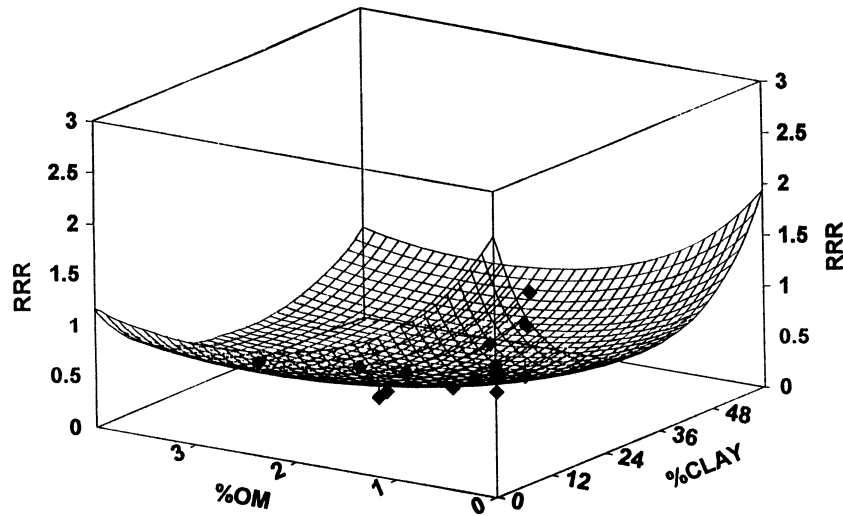


Figure 6. Measured random roughness decay by Gilly and Kottwitz (1995) and predicted by equations (11) and (14).

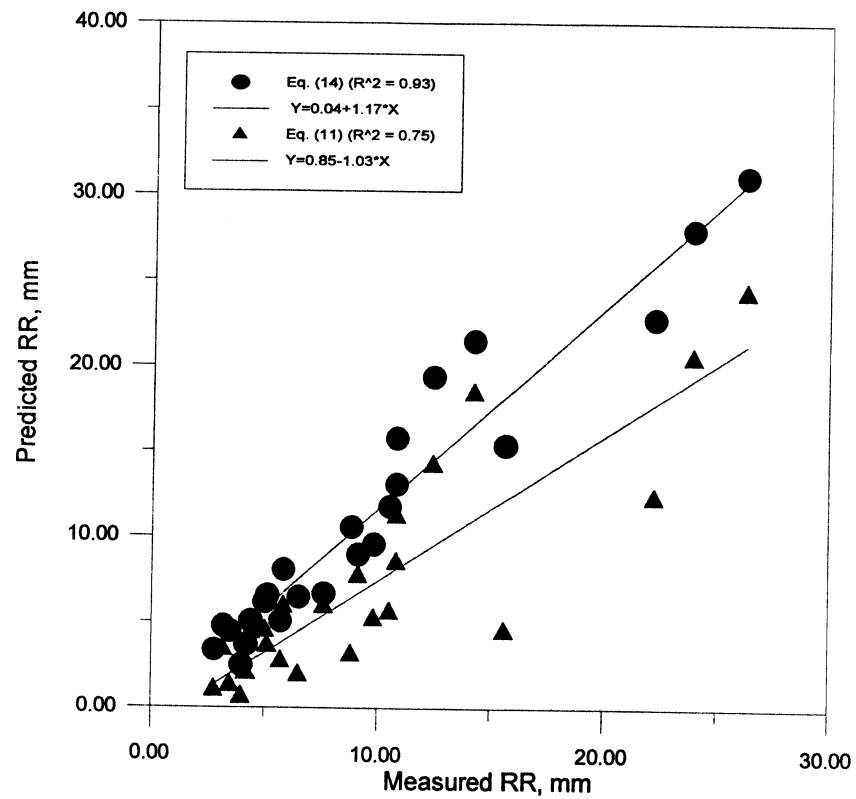
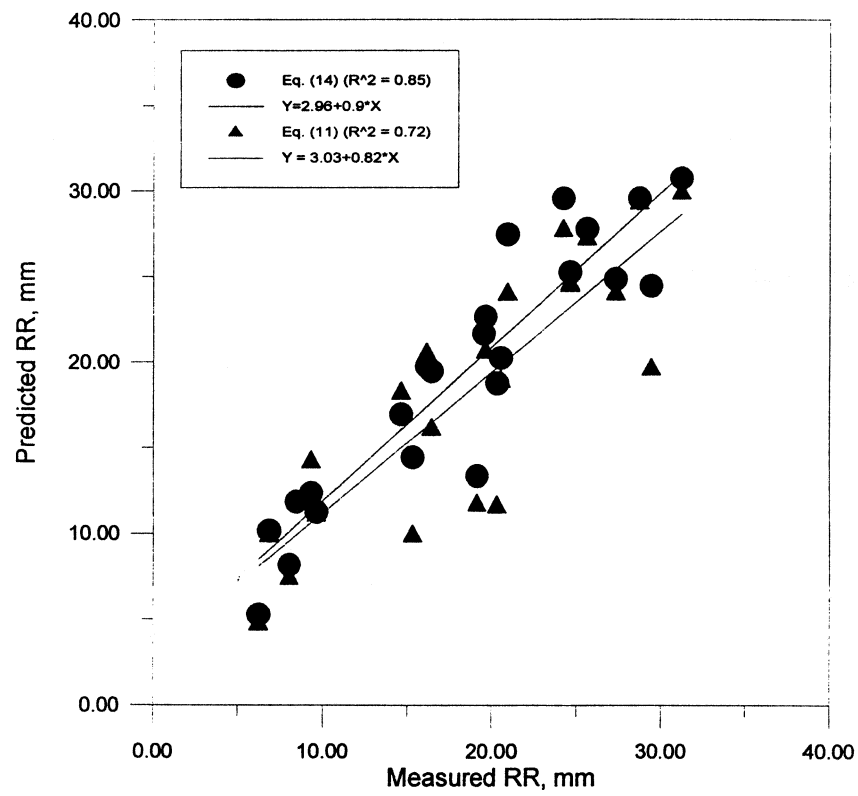


Figure 7. Measured random roughness decay by Potter (1990b) and predicted by equations (11) and (14).



SOIL ROUGHNESS FOR THE REVISED WIND EROSION EQUATION
RWEQ

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ABSTRACT

Soil surface aggregates (random roughness) and ridges (oriented roughness) can reduce soil loss by wind erosion. The soil roughness factor (K') is used to describe the effect of soil roughness on soil loss by wind. The K' in the Wind Erosion Equation (WEQ) model is a ridge roughness value which does not include the random roughness effect and is not modified by rainfall. This study was conducted to develop a soil roughness factor for the Revised Wind Erosion Equation (RWEQ) model. Wind tunnel data was used to generate the roughness factor which included both aggregate (random) and ridge (oriented) roughness. Surface roughness decay functions were used to predict K' (ridge and aggregate levels) after each rainfall event using rainfall amount and storm erosivity index (EI). A function was used to predict K' parallel and perpendicular to the wind for ridged fields. The soil surface roughness measurement obtained from the chain method and ridge height and spacing can be used to estimate K' . A look-up table was developed to obtain K' based on soil surface roughness measurements.

INTRODUCTION

Soil erosion by wind occurs when (1) wind velocity exceeds the threshold required to initiate soil movement, (2) soil particles are small enough to erode, and (3) the soil surface is not protected by crop canopy, residue, and/or roughness (aggregates and ridges). To reduce wind erosion, wind velocity at the surface must be reduced below the threshold velocity required to initiate soil movement. Flat and standing crop residues, crop canopy, wind barriers (Bilbro and Fryrear, 1985; Bilbro and Fryrear, 1988; Chepil and Woodruff, 1963; Lyles and Allison 1976; van de Ven *et al.*, 1989) and soil surface roughness are among the most important factors reducing wind velocity at the surface (Armbrust *et al.*, 1964; Chepil and Woodruff, 1963; Fryrear, 1984).

Soil surface roughness, including ridges and aggregates, reduces wind erosion. Since 1992, U.S. Department of Agriculture, Agricultural Research Service scientists have been developing a predictive model to replace the Wind Erosion Equation (WEQ) model. This new predictive technology, the Revised Wind Erosion Equation (RWEQ), incorporates the most current science in wind erosion (Fryrear *et al.*, 1997).

Chepil and Woodruff (1963) stated that “ Lister operation through the processes of increasing the nonerodible fractions and increasing the surface roughness, has reduced wind erosion from a very high amount to an insignificant amount”. Armbrust *et al.* (1964) conducted a wind tunnel study to evaluate the effect of ridges and aggregates on soil erosion by wind. They exposed dune sand mixed with various percentages of gravel, by weight, formed in ridges of various heights, to different levels of wind velocity and collected the eroded soil at the end of the tunnel. They concluded that ridges larger than 0.051 m and smaller than .102 m high eroded little due to trapping of soil particles between ridges. However, they suggested that extensive erosion on ridges higher than .102 m resulted from higher wind velocity at the ridges crests. The Armbrust *et al.* (1964) study was used to derive the K' factor in the WEQ model.

Fryrear (1984) conducted a wind tunnel test to evaluate soil losses from different surfaces. Conditions consisted of a surface with ridges 0 to 25.4 cm high with 0 to 60% of the surface covered with nonerodible aggregates. Soil losses were reduced 90% with ridges 6.3 to 25.4 cm high, 89% with nonerodible soil aggregates covering 60% of the soil surface, and 98% with a combination of large ridges and 40% coverage by aggregates. Data regarding soil loss and roughness from other studies (Chepil and Doughly, 1939; Fryrear and Armbrust, 1969) support these findings.

Zingg *et al.* (1953) measured soil loss with a portable wind tunnel in the field at various sites in New Mexico. They obtained soil loss of 515.6 Mt/ha from a flat sandy soil and about 4.9 Mt/ha from the same field with ridges of 25 cm high and 100 cm apart. According to the Armbrust *et al.* (1964) study, estimated soil loss for this field with ridges would be about 310 Mt/ha. Whereas, according to Fryrear (1984) the estimated soil loss would be about 46 Mt/ha.

Soil roughness has been expressed in different terms by various scientists. Zingg and Woodruff (1951) described an index for soil roughness due to the ridges as follows:

$$K_r = 4 \times \frac{H^2}{S} \quad (1)$$

where

K_r = soil ridge roughness factor, cm
 H = ridge height, cm
 S = ridge spacing, cm.

Allmaras *et al.* (1966) developed a random roughness index (RR) to characterize soil surface roughness due to aggregates. The term “RR” is based on the standard error of adjusted natural log-transformed surface elevations. Before computation of this index, the effect of slope and oriented roughness (OR) is removed. Also, to eliminate possibly erratic measurement effects, 10 percent of highest and lowest height measurements are eliminated.

Saleh (1993) developed a method to measure soil surface roughness using a roller chain. This method is based on the principle that when a chain of given length (L_1) is placed upon a surface, the horizontal distance between chain ends (L_2) will decrease as the roughness increases. Soil surface roughness (C_r) is calculated using the L_2/L_1 ratio as follows:

$$C_r = \left(1 - \frac{L_2}{L_1} \right) \times 100 \quad (2)$$

The current roughness factor (K') in the WEQ program does not include random (aggregates) roughness effects and does not decay by rainfall. The objectives of this study are (I) to incorporate the random roughness (aggregates) effects in the K' , (ii) to incorporate a function to

predict the K' at any wind angle relative to the soil ridges, and (iii) to incorporate functions to modify K' (ridges and aggregates) with rainfall amount and rainfall erosivity index (EI).

METHODS AND MATERIALS

New Roughness Factor (K'):

Data from Fryrear (1984) (Table 1) was used to generate the roughness factor (K') which includes both random (aggregates) and oriented (ridges) roughness. K' was obtained by computing the ratio of measured soil loss from ridged and aggregated surfaces to that of a flat surface. The following conditions are considered in K' .

1. Random roughness (RR): aggregated field with no ridges
2. Oriented roughness (OR): field with only ridges and no significant aggregates
3. Oriented and random roughness: surface covered with both ridges and aggregates

Condition number 3 is more representative of normal field conditions than 1 or 2.

Roughness Parameters:

Surface conditions similar to those used by Fryrear (1984) were recreated as follows:

1. Flat surfaces covered by triangular shaped ridges 0, 6.3, 12.7, and 25.4 cm high on a 1 to 4 height-width ratio.
2. Nonerodible artificial clods 4.5 cm in diameter, 2.5 cm high, paraboloid in shape with flat bottom uniformly distributed on ridges to cover 20, 40, or 60% of the surface.

Surface random roughness was measured by the chain method (Saleh, 1993) as follows:

1. A 0.01 m linked roller chain (ANSI 35 riv. Type) one meter long was laid out on the surface parallel to the ridges (when ridges existed).
2. A caliper rod was used to read the linear distance (L_2).
3. Equation (2) was used to calculate C_r .

With no ridges C_r is chain roughness due to random roughness. The measurement of C_r is made with the chain parallel to the ridges.

Ridge heights (H) were determined from the maximum difference between elevations measured parallel to tillage marks. Ridge spacing (RS) was determined by measuring the distance between ridges. Equation (1) was used to calculate the ridge roughness factor (K_r).

RESULTS AND DISCUSSION

Describing Soil Roughness:

As C_{rr} and K_r increase, soil loss decreases. Table 1 also indicates that ridges (K_r) more effectively reduce wind erosion than random roughness (C_{rr}). To describe the integrated effect of oriented and random roughness on K' , equation (3) was obtained by regressing K' on K_r and C_{rr} from Table 1.

$$K' = e^{[1.88 K_r - 2.44 K_r^{0.934} - 0.124 C_{rr}]} \quad (3)$$

$$R^2 = 0.984, P < 0.001$$

where

- K' = roughness factor (0 for extremely rough surface, 1.0 for flat surface)
- K_r = soil ridge roughness factor, cm (see equation 1)
- C_{rr} = soil random roughness parallel to ridges by the chain method.

Table 2 was developed by computing K' using equation [3] with various K_r and C_{rr} . For example:

1. For a surface with $C_{rr} = 10$ and $K_r = 0$ (no ridges), $K' = 0.29$.
2. For ridges 10 cm high and 40 cm apart, $K_r = 10$ cm (equation [1]). With no aggregates ($C_{rr} = 0$) and a wind direction perpendicular to ridges (0 degree), $K' = 0.12$.
3. For a surface with aggregates ($C_{rr} = 10$) and ridges ($K_r = 10$ cm) and a wind direction perpendicular to ridges (0 degree), $K' = 0.04$.

Soil surface roughness is described for the two dominant directions (parallel and perpendicular to the ridges). Saleh (1994) described a procedure to estimate soil roughness at any given angle (R_c) with respect to ridge orientation as follows:

$$R_c = 1.0 - [3.2E - 4\theta + 3.49E - 4\theta^2 - 2.58E - 6\theta^3] \quad (4)$$

where θ is the angle from the direction perpendicular to the ridges (degrees).

Equation (5) is used to compute K' at any wind direction ranging from perpendicular to parallel to the ridges:

$$K' = e^{[R_c \times (1.86 K_r - 2.411 K_r^{0.934}) - 0.124 C_{rr}]} \quad (5)$$

At a direction parallel to the ridges, ridge effect is negligible and only random roughness prevails. With no ridges ($K_r = 0$) all K' are equal regardless of wind direction. The K' for ridged fields with the wind at 90 degree (parallel to the ridges) equal the K' for no ridge conditions (Table 2). K' at directions of 30, 45, and 60 degrees to perpendicular direction of ridges are also presented (Table 2). For example, for $K_r = 10$ cm (ridges 10 cm high and 40 cm apart) and $C_{rr} = 10$:

- at 0 degree $K' = 0.04$
- 30 degrees $K' = 0.05$
- 45 degrees $K' = 0.06$
- 60 degrees $K' = 0.10$
- 90 degrees $K' = 0.29$ (parallel to the ridges gives random roughness only) .

Soil roughness is a dynamic wind erosion control factor that is readily modified by tillage types and direction and weather.

The RWEQ model decays roughness following a rainfall event. Field and laboratory experiments were conducted to develop the relationship between surface random (C_{rr}) and oriented (K_r) roughness decay as a function of rainfall amount and rainfall erosivity index (EI) (Saleh, 1997). Equation (6) was developed from regressing the log of RRR (ratio of random roughness after rainfall to initial random roughness) on CUMEI and CUMR:

$$RRR = e^{[DF(-0.0009 CUMEI - 0.0007 CUMR)]} \quad (6)$$

$$R^2 = 0.95, P < 0.001$$

where

CUMEI = cumulated EI, *Mj-mm/ha-hr*
 CUMR = cumulated precipitation, *mm*
 DF = decay factor based on soil clay and organic matter content.

The value of DF is obtained as follows:

$$DF = e^{[0.943 - 0.07\%CLAY + 0.0011\%CLAY^2 - 0.674\%OM + 0.0001\%OM^2]} \quad (7)$$

where

CLAY = clay content, %
 OM = organic matter, %.

Equation (8) was obtained by regressing ORR (oriented roughness after rainfall/initial oriented roughness) on cumulated rainfall (CUMR) and cumulated EI (CUMEI).

$$ORR = e^{[DF(-0.025 CUMEI^{0.31} - 0.0085 CUMR^{0.567})]} \quad (8)$$

$$R^2 \geq 0.99, P < 0.001$$

Equations (6), (7), and (8) are used in RWEQ to describe the effect of for soil surface random and oriented roughness on soil erosion by wind. For example, for a field with ridges 10 cm height 40 cm apart ($C_{rr} = 10$), 10% clay, and 1% organic matter gives $DF = 0.82$ and $K_r = 10$ cm. After 200 mm of rainfall (assuming $CUMEI = 1500$ *Mj-mm/ha-hr*), $K_r = 7.1$ cm (29% decay), C_{rr} would reduce to 2.96 (71% decay), and K' would increase from 0.03 to 0.11 (Table 2). This means that soil surface roughness would be less effective in controlling erosion after the rainfall event. Soil ridges decay at a much slower rate than aggregates. Therefore, ridges are more effective than aggregates for controlling erosion over extended periods when the wind direction

is perpendicular to ridges, especially for high rainfall areas and irrigated lands. However, one advantage of aggregates is that they protect the soil surface from erosion in all directions.

The soil surface random roughness of a soil surface can be estimated from direct observation, photographs, or from chain method. In describing soil surface roughness, a “non-aggregated” flat soil surface has no effect on wind erosion and $K' = 1.0$ (Table 2). A field with “low aggregation” has a surface composed of a low number of small aggregates (less than 5 cm in diameter, $C_{rr} < 4.0$ and > 1.0) which results in K' values ranging from 0.61 to 0.88 (Table 2). A field with a “medium aggregation” is composed of aggregates of less than 10 cm and greater than 5 cm in diameter ($C_{rr} > 4.0$ and < 10.0) for which K' ranges from 0.61 to 0.29 (Table 2). A field with aggregates greater than 10 cm in diameter is considered as a “high aggregation” field ($C_{rr} > 10.0$) for which K' would be less than 0.29.

SUMMARY AND CONCLUSIONS

Soil roughness is one of the management tools used to control wind erosion. It is now possible to (1) quickly measure soil surface roughness in the field using the chain method, (2) express these measurements in terms of a soil roughness factor (K') for wind erosion models, (3) express the changes in K' at any direction, and (4) decay surface roughness including ridges and aggregates with rainfall amount and rainfall erosivity index (EI), and (5) estimate the protection level that soil surface roughness might provide at different directions to the ridges during a wind erosion event using the look-up table. As Chepil and Woodruff (1963) stated soil roughness can reduce wind erosion significantly by increasing nonerodible aggregates and raising the threshold wind velocities at the surface. Crop residues are the best management practice to control wind erosion when appropriate environmental conditions (*e.g.* rainfall) exist. However, in semiarid regions such as the Southern Great Plains, where the production of adequate residue is limited, soil surface roughness induced by tillage is the primary means for effective wind erosion control.

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Table 1. Soil ridge roughness (K_r) and soil loss data from Fryrear (1984), chain reading (C_{rr}), and K' calculated by dividing each soil loss by 285 (soil loss for flat, smooth surface).

	C_{rr}							
	0		7.97		11.65		17.50	
K_r <i>cm</i>	Soil Loss <i>g/10 min</i>	K' <i>cm</i>	Soil Loss <i>g/10 min</i>	K' <i>cm</i>	Soil Loss <i>g/10 min</i>	K' <i>cm</i>	Soil Loss <i>g/10 min</i>	K' <i>cm</i>
0.0	285.0	1.0	125.5	0.44	52.7	0.19	14.5	0.05
6.3	42.2	0.15	28.9	0.10	23.0	0.08	10.2	0.04
12.7	29.2	0.10	10.2	0.04	9.9	0.04	3.0	0.01
25.4	30.7	0.11	9.9	0.04	5.6	0.02	3.8	0.01

Table 2. Soil roughness factor (K') using equation (3) with K_r and C_{rr} at 0, 30, 45, 60, and 90 degrees perpendicular direction to the ridges.

K_r cm	Angle deg.*	C_{rr}													
		0	2	4	6	8	10	12	14	16	18	20	22	24	26
0	0	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
	30	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
	45	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
	60	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
2.5	0	0.36	0.28	0.22	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01
	30	0.45	0.35	0.27	0.21	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02
	45	0.52	0.40	0.32	0.25	0.19	0.15	0.12	0.09	0.07	0.06	0.04	0.03	0.03	0.02
	60	0.65	0.51	0.40	0.31	0.24	0.19	0.15	0.12	0.09	0.07	0.05	0.04	0.03	0.03
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
5.0	0	0.21	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.01
	30	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01
	45	0.35	0.28	0.21	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01
	60	0.50	0.39	0.30	0.24	0.18	0.14	0.11	0.09	0.07	0.05	0.04	0.03	0.03	0.02
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
7.5	0	0.15	0.12	0.09	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01
	30	0.21	0.16	0.13	0.10	0.08	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
	45	0.26	0.21	0.16	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01
	60	0.40	0.31	0.24	0.19	0.15	0.12	0.09	0.07	0.06	0.04	0.03	0.02	0.02	0.02
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
10.0	0	0.12	0.09	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
	30	0.16	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01
	45	0.21	0.16	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01
	60	0.33	0.26	0.20	0.16	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
12.5	0	0.10	0.08	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	30	0.14	0.11	0.07	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
	45	0.17	0.14	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.02	0.01	0.01	0.01
	60	0.28	0.22	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.02	0.01	0.01
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
15.0	0	0.10	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	30	0.12	0.09	0.07	0.06	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
	45	0.15	0.12	0.09	0.07	0.06	0.07	0.06	0.03	0.02	0.03	0.01	0.01	0.01	0.01
	60	0.25	0.19	0.15	0.12	0.09	0.02	0.02	0.04	0.03	0.01	0.02	0.02	0.01	0.01
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
17.5	0	0.09	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	30	0.11	0.08	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	45	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
	60	0.22	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.2	0.01	0.01	0.01	0.01
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04
20.0	0	0.09	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	30	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	45	0.12	0.09	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
	60	0.19	0.15	0.12	0.09	0.07	0.06	0.04	0.03	0.03	0.2	0.01	0.01	0.01	0.01
	90	1.00	0.78	0.61	0.47	0.37	0.29	0.23	0.18	0.14	0.11	0.08	0.07	0.05	0.04

* Angle is measured in degrees from direction perpendicular to the ridge.

RWEQ - Crop Residue Decomposition

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The Revised Wind Erosion Equation (RWEQ) was developed to predict soil loss due to wind using monthly climate data and empirical formulas that consider the effects of soil, crop, and management practices (Fryrear et al., 1994) by the Agricultural Research Service of the United States Department of Agriculture. **RWEQ** uses monthly data but outputs information twice monthly. The residue decomposition component of **RWEQ** was developed to predict residue orientation, mass, and cover based on the decomposition model used in the Wind Erosion Prediction System (**WEPS**) (a daily time step model). Because of the difference in time steps between the two models several of the concepts used in **WEPS** were modified to work in **RWEQ**. The basic hypothesis is that decomposition coefficients account for differences in chemical and physical properties of the residues. Temperature and water functions relate climatic conditions in the field to optimum conditions in the laboratory. Climate functions lead to a decomposition day concept much like a growing degree day where optimum conditions produce one decomposition day in a 24 hour period, while less than ideal conditions produce a fraction of a decomposition day.

In **RWEQ** mass loss is predicted based on an exponential decay equation

$$M_t = M_o * e^{(-k * time)}$$

The equation estimates mass **M_t**, at time **t** from the initial mass, **M_o**, the decomposition rate, **k**, and **time**, since the harvest of the crop. The decomposition coefficients in **RWEQ** were determined from published articles relating decomposition of whole residue material. **Time** is calculated as decomposition days by using a climatic factor to estimate the relative decomposition conditions during the period. When the climatic factor is optimum during the period then one decomposition day accumulates for each day of the period and decomposition is occurring at the maximum rate determined by **k**. If temperature or water availability are suboptimal few decomposition days and less decomposition are predicted for the period.

Initialization of Decomposition

Crop harvest initializes the residue decomposition routines. The amount of residue at harvest is estimated from yield. Biomass is distributed between standing and flat components based on the harvest height. Economic yield, plant population, crop height and harvest height parameters should be adjusted based on a producers previous management history. These variables are used to estimate the initial residue level, partitioning of residue mass into standing (M_s) and flat (M_f) pools, and initial stem number (**PSN**).

The total above ground dry matter (**ADM**) and mass remaining (**RESM**) after the yield component is removed are estimated as follows:

$ADM = ya + yb * Y$ where **ya** is the intercept and **yb** the slope for the relationship between **Y** the economic yield and total biomass (**ADM**) and

$RESM_i = ADM - (Y * tof)$ where **RESM_i** is the residue mass, **ADM** is the above ground dry matter, **Y** is the economic yield and **tof** is the take off factor which is used for cotton or other crops where a portion of the material removed from the field is non-economic yield.

The coefficients for **ya** and **yb** were determined from published reports in scientific journals or extension articles where biomass at harvest and yield were reported. A number of examples of the type of relationships and data used for the developing the coefficients in **RWEQ** are presented in the appendix.

Partitioning of residue between flat and standing material after harvest is based on the height of the crop before and after harvest.

$$Mass_flat = RESM * (Crop_ht - harvest_ht) / Crop_ht$$

$$Mass_stand = RESM - Mass_flat$$

In the event that multiple years of a crop sequence is being simulated, each harvest will require initialization. The new M_f and M_s should be added to any value remaining in that variable. If any stems from the previous crop are still standing then the new stem

number value should be added to the old value.

Mass and Cover Losses

For each time step climatic data are used to calculate the number of decomposition days (DD_p) for the period. Changes in mass, stem number and cover are updated for each period.

Decomposition days (DD_p): The DD_p in **RWEQ** is calculated as follows:

$$DD_p = 1.25 * TC * RAINDAYS.$$

The DD_p for the period is a function of temperature (**TC**) and **RAINDAYS**. Temperature acts to control the rate of decomposition by its control on the rate of chemical and biological reactions particularly the rate of enzyme reactions important in the breakdown of plant material. The **TC** value for each period is calculated with an equation modified from Stroo et al. (1989).

$$TC = \frac{2 \cdot (T - A)^2 \cdot (T_{opt} - A)^2 \cdot (T - A)^4}{(T_{opt} - A)^4}$$

T Period temperature (°C),

T_{opt} Optimum temperature (32 C),

A Coefficient indicating lower limit for microbial activity (OC)

RWEQ calculates **TC** values for the maximum and minimum temperatures for the period and then averages to get a **TC** value for the period. A is set to 0° to limit microbial activity when temperature is below freezing. The optimum temperature for decomposition is set to 32 C. The minimum value for **TC** is zero.

Water impacts decomposition through its effect on the mobility of microorganism and enzymes. To be effective in the decomposition process microorganisms and their enzymes must move to the residue and brake-down products must diffuse back to the microorganisms to serve as a source of energy and building material. **RWEQ** calculates **RAINDAYS** from the number of days with rain for the month (the value is

halved for each semimonthly time step).

$$\text{RAINDAYS} = (\text{number of rain days in the month})$$

In **RWEQ** we assume that decomposition is restricted by water availability on days without precipitation and there would be no decomposition. On days with rain, water is not limiting and the amount of decomposition is a fraction of one decomposition unit based on the value estimated for **TC**. The **1.25** multiplier used to calculate **DD_p** was included to extend the impact of a single rainfall event beyond one day. This produced a similar cumulative climate index value using monthly data as when using the **WEPS** model which accumulated the daily minimum of a temperature or water coefficient (Steiner and Schomberg, unpublished data from semiarid locations).

Mass loss for standing and flat residues

Mass in the flat and standing pools is calculated each period as a function of **DD_p** using the numerical form of the exponential equation. This form is used so that changes in mass or stem number due to mangement operations can be easily incorporated into the calculations.

$$M_{flat} = M_{flaty} * (1 - K_{flat}) * DD_p$$

and

$$M_{stand} = M_{standy} * (1 - K_{stand}) * DD_p$$

where the subscript y indidcates the value from the previous time step.

Conversion of standing residues to flat residues

Initialization of the stem fall routines begins after the number of decomposition days exceeds a threshold value (**DD_o**). The number of decomposition days since harvest are summed in the variable **DD_{cum}**.

$$DD_{cum} = DD_{cum} + DD_p$$

Stem fall is estimated similar to that of mass loss

$$SN = SN_y * (1 - K_{sn}) * DD_p$$

where stem number (**SN**) for a period is estimated from the **SN** of the previous period. The equations and coefficients for this equation were determined for small grains by Steiner et al., (1994). As stems fall, mass from the standing pool is added to the flat pool.

$$M_f = M_f + M_s * (PSN - SN) / PSN$$

and mass is removed from the standing pool.

$$M_s = M_s (1 - ((PSN - SN) / PSN))$$

Soil Cover and Stem Silhouette Area

The percent soil cover is calculated using the **flat** residue mass:

$$COV_{flat} = 100 (1 - e^{(mcf * Mf)})$$

Exponential relationships between mass and percent soil cover have traditionally been used. These relationships are species specific and are generally good when developed using randomly distributed, uniform sized pieces of residues. In, field experiments, these relationships are not as clear-cut and are affected by a number of factors. Data collected in a small grain study at Bushland, TX (see appendix) indicated that percent cover was more clearly related to the flat surface residue biomass than to total above ground residue. The relationship is also considerably different between two sample dates (July, 1991, 3 weeks after harvest and August, 1992, 13 months after harvest) particularly when cover is related to total above ground biomass. Using published coefficients, nadir-view cover will generally be overestimated when a large portion of the biomass is in standing stems or oriented in rows rather than randomly distributed. This bias may be partially offset because most precipitation does not fall perpendicular to the earth's surface and standings stems are more effective at intercepting blown precipitation than would be predicted by the nadir view percent cover.

The stem silhouette area, **SA**, is calculated as:

$$SA = (harvest\ height) * (stem\ diameter) * (stem\ number)$$

Revised Wind Erosion Equation (RWEQ)

Crop Residue Decomposition

Variable list:

Input table:

CH	m	Crop height prior to harvest
HH	m	Harvest height
SDIAM	m	Stem diameter
SN _i	stems/m ²	Stem number at harvest
Y	kg/ha	Marketable yield
dd _o	d	Stem number threshold decomposition days
k _{mf}	d ⁻¹	Rate coefficient for flat mass loss
k _{ms}	d ⁻¹	Rate coefficient for standing mass loss
k _{sn}	d ⁻¹	Rate coefficient for stem number decline
mcf	%(kg/ha)	Mass: cover conversion factor
ya	(kg/ha)	intercept for yield: drymatter regression
yb	unitless	slope for Yield: drymatter regression
tof	unitless	takeoff factor (if no residue is removed from field, set to 1)

Global - required from other routines:

T _{max}	°C	Average daily maximum temperature by period
T _{min}	°C	Average daily maximum temperature by period
RAINDAYS	d	Average number of precipitation days by period

Internal:

ADM	kg/ha	Aboveground drymatter prior to harvest
M _f	kg/ha	Mass "flat" on surface
M _s	kg/ha	Mass in standing stems
RESM _i	kg/ha	Residue mass in field after harvest
SN	stems/m ₂	Standing stem number
TC	unitless	Temperature coefficient ($0 \leq TC \leq 1$)
DD _p	d	Decomposition days (DD) for the period
DD _{cum}	d	Cumulative DD since harvest

Global - provided to other routines:

SA	m ² /m ²	Silhouette area per unit soil area
COV _f	%	Percent soil cover

Parameter	Units	Winter	Spring	Oats	Barley	Sunflower	Cotton	Soybean	Corn	Sorghum	Alfalfa	Ryegrass
Y	kg/ha	2000	2000	2000	2000	1000	1000	2000	8000	4000		
CH	m	1	1	1	1	1.5	.7	.7	2.5	1		
HH	m	.25	.25	.25	.25	.5	.5	0	.5	.4	0	
SN	#/m ²	500	500	500	500	12	30	20	6	12		
SDIAM	m	.005	.005	.005	.005	.03	.01	.01	.03	.03		
tof	1	1	1	1	1	1	Strip:4.5 Pick: 3.2	1	1	1	1	1
ya	kg/ha	380	380	380	380	0	0		3700	1120		
yb		2.25	2.25	2.25	2.25	3.6	9.25		1.5	1.85		
k _{ml}	d ⁻¹	0.013										
k _{ms}	d ⁻¹	0.0013										
k _{sn}	d ⁻¹	0.169	0.116	0.284	0.176							
dd _o	d ₁	17	17.8	17.6	17.3							
mcl	%/(kg/ha)	-0.00065	-0.00065	-0.00119	-0.00065	-0.00017	-0.00025	-0.00065	-0.00043	-0.0003		

11 February 1997

STOCHASTIC WIND SIMULATION FOR EROSION MODELING

E. L. Skidmore, J. Tatarko

ABSTRACT

The purpose of this study was to develop a wind simulator to furnish wind direction and sub-hourly wind speed to users of wind speed information, particularly for wind erosion modeling. We analyzed the Wind Energy Resource Information System data to determine scale and shape parameters of the Weibull distribution for each of the 16 cardinal directions for each month at 704 locations in the United States. We also summarized wind direction distributions, ratio of daily maximum to daily minimum wind speed, and hour of maximum wind speed by month for each location. This summary of historical wind statistics constitutes a compact data base for wind simulation. Equations were formulated and procedures developed and used with the compact data base and a random number generator to simulate wind direction and sub-hourly wind speed. Cumulative wind speed distributions, calculated from the Weibull parameters, and wind speeds simulated at one-hour intervals for 1000 days agreed well. The model reflects historical day-to-day wind variation and wind speed variations within a day. It will be useful to those needing wind speed and wind direction information and will provide the wind simulator requirements in a wind erosion prediction system. **KEYWORDS.** Erosion, Modeling, Wind simulation.

INTRODUCTION

The wind is of interest to many people. Wind energy developers, hydrologists, meteorologists, climatologists, farmers, ranchers, sportsmen, environmentalists, conservationists, agricultural pest managers, homemakers, and others all have reasons to know about the wind. This need for information about the wind has prompted several studies, particularly by those interested in wind as a source of energy (Hagen et al., 1980; Reed, 1975; Elliot et al., 1986) and those concerned with erosion of soil by wind (Lyles, 1976, 1983; Zingg, 1949; Skidmore, 1965, 1987).

Sometimes knowing wind speed without concern for wind direction is sufficient and, thus, many of the wind studies do not consider a wind direction component. But for application to wind erosion, wind direction is critical

(Skidmore, 1987; Skidmore and Hagen, 1977; Skidmore and Woodruff, 1968). Wind direction relative to the orientation of fields and wind barriers is important in determining wind travel distance from a non-eroding boundary and enters into the estimation of wind erosion. Wind direction relative to the direction of row crops and some tillage operations also enters into the calculation, as does the constancy or preponderance of wind in the prevailing wind erosion direction. Both wind speed and wind direction are important in studies of evaporation from lakes and evapotranspiration from row crops.

Prediction of wind speed and direction, like most meteorological variables, is extremely difficult. Even with advanced technology, such as sophisticated numerical models and super computers, using climatological means is as accurate as predicting meteorological variables for a time period of more than a few days in advance (Tribbia and Anthes, 1987). Therefore, we resort to historical statistical information about most meteorological variables and use stochastic techniques to determine likelihood of various levels of the variable of concern.

Various models have been used to describe wind speed distribution. A glance at a frequency versus wind speed histogram shows that the distribution would not be described best by the familiar normal distribution. Distributions that have been used to describe wind speed include the one-parameter Rayleigh (Hennessey, 1977; Corotis et al., 1978), the two-parameter gamma (Nicks and Lane, 1989), and the two-parameter Weibull (Takle and Brown, 1978; Corotis et al., 1978). The Weibull is undoubtedly the most widely used model of common wind behavior representing wind speed distributions.

McWilliams et al. (1979) presented a model for the joint distribution of wind speed and direction. They assumed that the components of wind speed are normally distributed along any given direction and that a component along the favored direction has a nonzero mean and a given variance; whereas a component along a direction at right angles is independent and normally distributed with zero mean and the same variance.

Dixon and Swift (1984) expanded upon the work of McWilliams et al. (1979), and McWilliams and Sprevak (1980) by proposing an empirical three-parameter model. Two of these are the familiar Weibull characteristic scale and shape factors. The third is a measure of directionality, which is a function of the ratio of probability densities for prevailing/antiprevaling directions.

These various models are not adequate for wind erosion modeling, which requires directional sub-hourly wind speeds. Thus, the specific purpose of this study was to develop a more detailed stochastic wind simulator to

Article was submitted for publication in June 1990; reviewed and approved for publication by the Soil and Water Div. of ASAE in October 1990.

Contribution from USDA-ARS in cooperation with Kansas Agricultural Experiment Station. Contribution No. 90-376-J.

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furnish wind direction and wind speed as needed by the Wind Erosion Prediction System described by Hagen (1990). A further requirement of the simulator is that it be capable of using the extensive wind data base summarized by the National Climatic Data Center.

COMPACT DATA BASE

One of the important requirements for a wind simulator for wind erosion modeling is to develop a compact data base. Although described elsewhere (Skidmore and Tatarko, 1990), we give here some of the details of creating the compact data base. Our database was created from historical monthly wind speed and wind direction summaries contained in the extensive Wind Energy Resource Information System (WERIS) data base at the National Climatic Data Center, Asheville, NC (NCC TD 9793). The WERIS data base is further described in appendix C of Elliot et al. (1986).

Data were extracted from WERIS tables and, in some cases, analyzed further to create a data base suitable for our needs. From WERIS Table 5, we obtained a ratio of maximum/minimum mean hourly wind speed and hour of maximum wind speed by month. From WERIS Table 10, we obtained monthly mean air density and occurrences of blowing dust. Air density is used to calculate wind power and wind shear stress. Although we are not using occurrence of blowing dust in our current modeling effort, we thought it important to archive in this data base for future studies.

We used data from WERIS Table 12 A-L, joint wind speed/direction frequency by month (Table 1), to calculate scale and shape parameters of the Weibull distribution function for each of the 16 cardinal wind directions by month.

The cumulative Weibull distribution function $F(u)$ and the probability density function $f(u)$ are defined by:

$$F(u) = 1 - \exp \left[- (u/c)^k \right] \quad (1)$$

and

$$f(u) = dF(u)/du = (k/c) (u/c)^{k-1} \exp \left[- (u/c)^k \right] \quad (2)$$

where

u = wind speed,

c = scale parameter (units of velocity), and

k = shape parameter (dimensionless) (Apt, 1976).

Since anemometer heights varied from location to location, all wind speeds (Column 1, Table 1) were adjusted to a 10 m reference height according to the following:

$$u_2 = u_1 (z_2 / z_1)^{1/7} \quad (3)$$

where

u_1 and u_2 = wind speeds at heights z_1 and z_2 , respectively (Elliot, 1979).

The calm periods were eliminated, and the frequency of wind in each speed group was normalized to give a total of 1.0 for each of the 16 cardinal directions. Thus,

$$F_1(u) = [(F(u) - F_0)/(1 - F_0)] = 1 - \exp \left[-(u/c)^k \right] \quad (4)$$

where $F_1(u)$ is the cumulative distribution with the calm periods eliminated, and F_0 is the frequency of the calm periods. The scale and shape parameters were calculated by

TABLE 1. Joint wind speed/direction frequency, March, Lubbock, TX (Table 12c of WERIS)

Speed (m/sec)	Wind Direction																CALM	Total
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW		
Calm	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.3	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.3	0.1	0.5	0.5	.6	0.4	0.5	0.2	0.0	4.1
3	0.7	0.3	0.5	0.4	0.9	0.4	0.6	0.5	0.9	0.4	1.1	1.1	10.5	0.8	0.7	0.3	0.0	11.1
4	1.0	0.6	0.8	0.4	1.1	0.9	1.0	0.8	1.9	0.6	0.8	1.2	1.6	1.2	0.7	0.5	0.0	15.1
5	0.9	0.6	0.8	0.5	0.9	0.9	1.0	1.3	2.1	0.9	1.2	1.2	1.6	0.5	0.4	0.5	0.0	15.4
6	0.7	0.7	0.6	0.4	0.6	0.5	0.9	0.6	1.6	1.0	1.1	1.2	0.7	0.6	0.3	0.5	0.0	12.2
7	1.0	0.6	0.6	0.4	0.2	0.5	0.4	0.5	1.6	1.0	1.4	0.8	0.7	0.5	0.3	0.2	0.0	10.0
8	1.0	0.6	0.8	0.2	0.5	0.3	0.6	0.3	1.4	1.2	1.0	0.6	0.7	0.4	0.4	0.2	0.0	10.1
9	0.8	0.4	0.6	0.2	0.3	0.1	0.2	0.4	1.0	0.8	0.7	0.6	0.6	0.4	0.2	0.3	0.0	7.6
10	0.3	0.4	0.2	0.2	0.1	0.0	0.1	0.2	0.8	0.4	0.2	0.3	0.4	0.3	0.1	0.1	0.0	4.3
11	0.3	0.4	0.1	0.1	0.0	0.0	0.1	0.1	0.5	0.2	0.3	0.3	0.5	0.1	0.1	0.1	0.0	3.1
12	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.2	0.4	0.1	0.1	0.0	0.0	1.6
13	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.2	0.1	0.3	0.2	0.1	0.1	0.0	1.3
14	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.1	0.0	0.0	0.7
15	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.5
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.2
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21 - 25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26 - 30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31 - 35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36 - 40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41 - up	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	7.8	4.8	5.1	2.9	4.9	3.8	5.1	4.9	12.2	6.8	8.9	8.5	9.9	5.7	4.0	3.0	1.7	100.0
Avg. speed	6.9	7.0	6.1	6.0	5.1	5.2	5.5	5.9	6.2	6.7	6.4	6.2	6.4	6.2	5.6	6.3	0.0	6.1

the method of least squares applied to the cumulative distribution function, equation 4. Equation 4 was rewritten as:

$$1 - F_1(u) = \exp \left[- (u/c)^k \right] \quad (5)$$

Then by taking the logarithm twice, this becomes:

$$\ln[-\ln(1 - F_1(u))] = -k \ln c + k \ln u \quad (6)$$

If we let $y = \ln[-\ln(1 - F_1(u))]$, $a = -k \ln c$, $b = k$, and $x = \ln u$, equation 6 may be rewritten as:

$$y = a + bx \quad (7)$$

$F_1(u)$ was calculated from information in tables like Table 1 for each wind speed group, to determine y and x in equation 7. This gave the information needed to use a standard method of least squares to determine the Weibull scale and shape parameters. To recover the real distribution, we can rewrite equation 4 as

$$F_1(u) = F_0 + (1 - F_0) \left\{ 1 - \exp \left[- (u/c)^k \right] \right\} \quad (8)$$

Wind direction distribution was summarized by month from the "total" row in Table 1 for each location.

Other pertinent data, obtained from the Wind Energy Resource Atlas of the United States (Elliot et al., 1986), included latitude, longitude, city, state, location name, Weather Bureau Army Navy (WBAN) number, period of record, anemometer height, and number of observations per 24 h period.

We eliminated WERIS sites if they represented less than 5 years of data, the anemometer height was not known, or fewer than 12 observations were taken per day. Where more than one satisfactory observation site/period remained in a metropolis, we picked the site with the best combination of the following:

1. Maximum number of hours per day observations were taken;
2. Longest period of record;
3. One hourly versus three hourly observations; and
4. Best location of anemometer (ground mast > beacon tower > roof top > unknown location).

RESULTS AND DISCUSSION

Tables 2, 3, 4, and 5 give examples of wind information we compiled into a compact data base for the simulation model.

The scale and shape parameters (Tables 4 and 5) are used in equations 1 and 2 to define the wind speed probability distribution functions and are, therefore, useful for describing the wind speed regime. Equation 2 can be used to calculate the probability of any specified wind speed. The integrated form of equation 1 can be used to calculate the probability of wind speeds being greater than, less than, or between specified values. The mean wind speed of the observation period from which the distribution parameters were calculated is very nearly 0.9 times the scale parameter (Johnson, 1978).

The following few paragraphs explain procedure to access the compact data base and simulate wind direction and wind speed.

DETERMINE WIND DIRECTION

This analysis for stochastic determination of wind direction and wind speed is applied to wind data as summarized by Tables 2, 3, 4, and 5. Specify the month by number (1 = January) and read the wind direction distribution array for the specified month. Calculate the cumulative wind direction distribution so that it ranges from 0 to 1.0. Draw a random number, RN , where $0 < RN < 1.0$ and compare it with the cumulative wind direction distribution. If the random number is equal to or less than the probability of the wind being from the north, then the simulated wind direction is north. If the random number is greater than the cumulative probability of the wind being from the north and equal to or less than the probability of the wind being from the north northeast, then the simulated wind direction is north northeast and so on. If the random number is greater than the cumulative probability of the wind being from all of the 16 cardinal directions, then the simulated wind is calm.

DETERMINE WIND SPEED

Once wind direction is simulated, access the data base to determine the Weibull scale, c , and shape, k , parameters for that direction and the month under consideration in preparation for the next step.

Rearrange equation 8 to make wind speed, u , the dependent variable:

$$u = c \left\{ -\ln[1 - (F(u) - F_0)/(1 - F_0)] \right\}^{1/k} \quad (9)$$

Draw a random number, $0.0 \leq RN \leq 1.0$, assign its value to $F(u)$, and compare it with the frequency of calm periods, F_0 . If $F(u) \leq F_0$, then u is calm. In the rare case that $F(u) = 1.0$, the argument of \ln in equation 9 is zero and does not compute. Therefore, if $F(u) > 0.999$, let $F(u) = 0.999$. Otherwise, calculate u from equation 9 for $F_0 \leq F(u) \leq$

TABLE 2. Ratio of maximum to minimum hourly wind speed, hour of maximum wind speed, air density and occurrences of blowing dust, Lubbock, TX (Skidmore and Tatarko, 1990)

	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Max/min	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.7	1.5	1.6	1.6	1.5
Hour max	15	12	15	15	18	18	18	15	15	15	12	15
Air den												
(kg/m ³)	1.14	1.13	1.11	1.09	1.07	1.06	1.05	1.06	1.07	1.09	1.12	1.13
Blow dust	43	56	122	119	41	28	3	3	1	4	25	49

TABLE 3. Wind direction distribution by month, Lubbock, TX (Skidmore and Tatarko, 1990)

Wind Direction	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
	-----%-----											
1	8.2	9.7	7.8	5.5	5.3	3.1	2.3	2.9	5.9	6.3	8.8	9.0
2	5.0	4.9	4.8	3.6	3.7	2.2	1.5	2.6	4.8	5.0	4.4	4.8
3	5.0	5.9	5.1	4.1	4.1	3.2	3.9	4.2	6.3	5.3	4.8	4.7
4	3.8	4.2	2.9	4.5	4.8	4.1	3.8	4.7	4.9	4.1	3.1	3.1
5	4.0	4.3	4.9	5.3	5.9	5.0	5.9	6.7	6.3	4.3	4.4	2.2
6	3.1	3.8	3.8	4.7	6.6	6.1	5.7	6.3	5.7	3.0	3.2	1.9
7	3.3	3.8	5.1	6.5	10.5	10.0	9.7	9.7	7.5	4.2	3.4	2.1
8	2.9	3.3	4.9	4.9	8.3	9.5	11.6	14.9	13.6	9.0	5.4	3.7
9	9.8	8.7	12.2	16.4	16.4	26.8	27.4	24.1	18.6	19.7	11.7	9.4
10	6.0	5.7	6.8	6.5	6.9	9.2	8.8	7.2	7.9	9.6	7.5	7.4
11	9.6	8.5	8.9	7.7	7.3	5.9	5.9	5.1	6.2	8.2	9.9	10.1
12	9.6	9.3	8.5	7.9	4.7	3.4	2.4	2.8	3.5	6.0	9.0	9.8
13	12.3	10.8	9.9	6.7	5.1	3.3	2.0	1.7	3.5	6.1	9.0	11.8
14	6.3	6.2	5.7	4.6	3.0	1.5	1.0	1.1	1.7	3.2	5.1	7.7
15	4.7	4.9	4.0	3.4	2.6	1.6	0.8	1.1	2.0	3.0	4.3	5.3
16	3.8	3.4	3.0	3.0	1.8	1.1	0.6	1.1	2.1	2.9	3.0	4.0
17	2.7	2.7	1.7	1.4	1.8	1.5	3.1	5.0	4.0	3.6	4.8	4.3

The directions are clockwise starting with 1 = north. Direction 17 represents calm periods.

0.999 to determine a period simulated wind speed. If the period is one day, then u represents simulated daily mean wind speed.

Many applications require additional information about how the wind speed might vary within a period. Consider a diurnal variation. Read from the wind data base the ratio of maximum to minimum wind speed and the hour of maximum wind speed for the location and month under consideration. Calculate the maximum and minimum wind speed for the day based on the representative wind speed as calculated above and given the ratio of u_{max} to u_{min} :

$$u_{rep} = (u_{max} + u_{min}) / 2 \quad (10)$$

$$u_{ratio} = u_{max} / u_{min} \quad (11)$$

calculated from equation 9, u_{ratio} is the ratio of daily maximum, u_{max} , to daily minimum, u_{min} , wind speed. Solving equation 10 and 11 for u_{max} and u_{min} gives:

$$u_{max} = 2 u_{ratio} u_{rep} / (1 + u_{ratio}) \quad (12)$$

$$u_{min} = u_{max} / u_{ratio} \quad (13)$$

Therefore, wind speed for any hour of the day $u(I)$ can be simulated from:

$$u(I) = u_{rep} + 0.5$$

$$(u_{max} - u_{min}) \cos[2\pi (24 - hr_{max} + I) / 24] \quad (14)$$

where u_{rep} is the daily mean representative wind speed as

where hr_{max} is the hour of the day when wind speed is

TABLE 4. Weibull scale parameters by month and direction. Wind speed was adjusted to a height of 10 meters, Lubbock, TX (Skidmore and Tatarko, 1990)

Wind Direction	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
	-----m/s-----											
1	8.0	8.2	8.8	8.3	8.0	7.6	5.8	5.0	6.4	7.5	7.5	7.9
2	8.2	9.2	9.0	8.6	8.3	7.6	6.0	5.7	7.3	7.5	6.7	8.1
3	6.6	7.8	8.0	8.3	7.9	7.2	5.8	5.8	5.9	7.0	6.5	6.8
4	6.5	6.5	7.8	6.9	7.3	6.3	5.9	5.2	5.3	6.2	5.7	6.3
5	6.0	6.3	6.7	6.4	6.6	6.3	5.2	4.8	4.6	5.2	5.0	5.0
6	5.3	6.4	6.8	7.1	7.1	6.2	5.3	5.0	5.2	5.1	5.1	4.2
7	5.5	6.4	7.2	7.2	7.4	6.8	6.0	5.5	5.5	5.3	4.8	5.2
8	5.9	6.1	7.5	8.5	8.0	7.5	6.3	5.8	5.9	6.2	5.8	5.2
9	6.2	7.0	7.9	8.5	8.1	8.0	6.8	6.5	6.5	6.6	6.2	6.5
10	7.2	7.2	8.7	8.5	8.1	7.7	6.9	6.5	6.9	6.9	6.9	7.4
11	7.3	7.6	8.2	8.4	7.6	6.9	6.1	5.9	6.1	6.2	6.5	6.9
12	6.5	7.0	8.0	8.6	7.8	7.0	5.4	5.0	5.2	5.9	6.4	6.0
13	6.7	6.8	8.3	8.8	7.2	6.4	4.9	4.4	5.3	5.1	6.3	6.4
14	7.1	7.2	7.8	8.1	7.0	5.6	4.3	4.2	4.6	5.1	6.0	6.9
15	6.1	6.1	7.2	7.2	7.1	5.3	4.6	4.5	4.4	4.9	6.4	6.5
16	7.1	7.7	7.7	8.3	6.6	5.7	4.8	3.9	4.9	6.4	7.1	7.2
17	6.8	7.3	8.1	8.2	7.7	7.3	6.3	5.8	5.9	6.3	6.4	6.7

The directions are clockwise starting with 1 = north. Direction 17 is for total wind.

**TABLE 5. Weibull shape parameters by month and direction, Lubbock, TX
(Skidmore and Tatarko, 1990)**

Wind Direction	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
	-----m/s-----											
1	2.5	2.5	2.7	2.6	2.8	2.3	2.2	2.6	2.3	2.5	2.7	2.7
2	2.8	2.4	3.2	2.9	2.8	2.7	3.2	2.3	3.1	2.8	2.7	2.6
3	2.8	3.1	3.3	2.8	2.7	2.9	2.8	3.3	3.2	3.3	3.0	3.2
4	3.9	3.4	3.0	3.5	3.0	2.6	2.8	2.9	3.2	3.1	2.7	3.2
5	3.1	3.2	3.3	2.9	3.0	3.4	3.1	3.2	3.3	3.0	3.6	2.8
6	3.4	3.6	3.9	3.3	3.6	4.4	3.7	3.9	3.3	3.5	3.6	5.1
7	3.7	3.3	3.3	3.3	3.4	3.6	3.5	3.5	3.9	4.1	3.6	5.4
8	3.2	4.1	3.3	3.5	3.3	3.5	3.8	3.7	3.5	2.9	3.0	4.5
9	2.9	3.2	3.6	3.3	3.3	3.7	3.7	3.7	3.4	3.3	3.3	3.2
10	3.1	3.5	3.7	3.7	3.2	3.5	3.9	3.6	4.0	3.2	3.5	3.2
11	3.4	3.2	2.7	3.2	3.2	3.0	3.5	3.0	3.4	3.0	3.2	3.2
12	2.5	2.6	2.5	2.4	2.5	2.9	3.4	3.6	3.0	2.7	2.6	2.6
13	2.1	2.4	2.2	2.5	2.6	2.2	3.3	3.1	3.0	2.4	2.2	2.2
14	2.1	2.2	2.3	2.5	2.4	3.6	4.1	3.5	2.6	2.4	1.8	2.0
15	2.4	2.6	2.2	2.5	2.5	3.1	3.3	2.9	2.9	2.0	2.2	2.3
16	2.2	2.6	2.7	2.3	2.8	3.3	2.6	3.5	2.5	2.1	2.4	2.4
17	2.6	2.6	2.7	2.9	3.1	3.1	3.3	3.2	3.0	2.7	2.6	2.6

The directions are clockwise starting with 1 = north. Direction 17 is for total wind.

maximum; I is index for hour of day, and the other variables are as previously defined.

OUTPUT FILE

Usually, the output of a wind simulation will be directed to the input of another process model, e.g., evaporation, wind energy, wind erosion, etc. We illustrate what the output of a few simulations may be like in Table 6. These simulations were generated by accessing data from Tables 2, 3, 4, and 5 for March and July and performing the operations described previously. After wind direction was determined based on wind direction probabilities, Table 3, and a random number generator, the appropriate Weibull scale and shape parameters were obtained from Tables 4 and

5. The model was run to produce the output shown in Table 6. Wind speed was printed every 2 h for each simulation.

If wind speed at any time exceeded 8 m/s, then it was flagged by a yes in the last column of Table 6. This means that wind speed is high enough to cause erosion from an unprotected surface of highly erodible particles, and an erosion sub-model should be activated.

Since Weibull scale factors describing wind speed distribution are indicative of higher wind speed in March than July, yes would appear more frequently, on the average for March than July, as it does in our small sample. Also, on the average of many simulations, the wind direction in the first column, Table 6, would reflect the direction distributions of Table 3.

TABLE 6. Wind direction and wind speed simulation for March and July, Lubbock, TX

Wind Direction	Hour of Day												Erosion
	1	3	5	7	9	11	13	15	17	19	21	23	
March	-----m/s-----												
13	3.3	3.2	3.3	3.7	4.1	4.6	5.0	5.1	5.0	4.6	4.1	3.7	No
11	4.6	4.4	4.6	5.1	5.7	6.4	6.9	7.0	6.9	6.4	5.7	5.1	No
13	2.7	2.6	2.7	3.0	3.4	3.8	4.1	4.2	4.1	3.8	3.4	3.0	No
4	6.2	5.9	6.2	6.8	7.7	8.6	9.3	9.5	9.3	8.6	7.7	6.8	Yes
9	6.9	6.7	6.9	7.7	8.7	9.7	10.4	10.7	10.4	9.7	8.7	7.7	Yes
11	8.0	7.7	8.0	8.9	10.0	11.2	12.0	12.4	12.0	11.2	10.0	8.9	Yes
10	5.4	5.2	5.4	6.0	6.8	7.6	8.1	8.3	8.1	7.6	6.8	6.0	Yes
12	1.7	1.7	1.7	1.9	2.2	2.4	2.6	2.7	2.6	2.4	2.2	1.9	No
5	3.4	3.3	3.4	3.7	4.2	4.7	5.1	5.2	5.1	4.9	4.2	3.8	No
7	7.3	7.0	7.3	8.1	9.2	10.2	11.0	11.3	11.0	10.2	9.2	8.1	Yes
July													
5	2.4	2.1	2.0	2.0	2.1	2.4	2.7	2.9	3.1	3.1	2.9	2.7	No
9	7.2	6.4	6.0	6.0	6.4	7.2	8.1	8.9	9.4	9.4	8.9	8.1	Yes
9	4.6	4.1	3.8	3.8	4.1	4.6	5.2	5.7	6.0	6.0	5.7	5.2	No
9	8.0	7.2	6.7	6.7	7.2	8.0	9.1	10.0	10.5	10.5	10.0	9.1	Yes
6	5.7	5.1	4.7	4.7	5.1	5.7	6.4	7.0	7.4	7.4	7.0	6.4	No
10	8.2	7.3	6.8	6.8	7.3	8.2	9.2	10.2	10.7	10.7	10.2	9.2	Yes
7	3.6	3.2	2.9	2.9	3.2	3.6	4.0	4.4	4.6	4.6	4.4	4.0	No
9	5.0	4.5	4.1	4.1	4.5	5.0	5.7	6.2	6.5	6.5	6.2	5.7	No
12	3.0	2.6	2.5	2.5	2.6	3.0	3.3	3.7	3.9	3.9	3.7	3.3	No
9	5.6	4.9	4.6	4.6	4.9	5.6	6.3	6.9	7.2	7.2	6.9	6.3	No

Directions are clockwise starting with 1 = north.

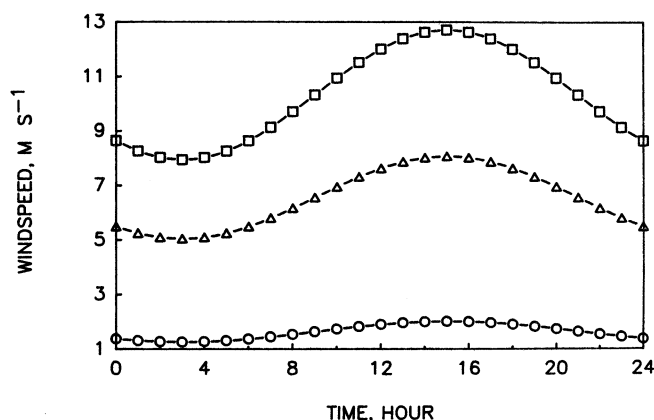


Figure 1—Hourly and daily variations of wind speed. The top and bottom curves are the highest and lowest, respectively, of a 10-day simulation. The middle curve is the average of 100 simulations, March, Lubbock, TX.

Table 6 and figure 1 illustrate that the model reflects historical day-to-day wind variations and the wind speed variation within a day.

COMPARISON

Measured and simulated average hourly annual wind speeds for Lubbock, TX were compared. The average annual wind speed at 3-h intervals was obtained from Table 06 of Elliot et al. (1986) and adjusted to 10 m height. Annual u_{max} , u_{min} , and h_{rmax} , obtained from the same source, were 6.55, 4.19 m/s, and 15 h, respectively. u_{max} , u_{min} , and h_{rmax} were used in equation 14 to simulate hourly wind speed and compared to measured wind speed in figure 2. This procedure forces agreement between simulated and observed values for daily maximum and minimum and ensures that the time of simulated maximum and observed maximum agree within frequency of reported wind speed observations. Since wind speeds often are reported only at 3-h intervals, the curves may not coincide. This was the case for the simulation in figure 2, so we set h_{rmax} at 14 instead of the reported 15.

The form of wind speed variation is not purely sinusoidal, which causes a discrepancy between simulated time of minimum wind speed and observed time of minimum wind speed. If we were primarily interested in

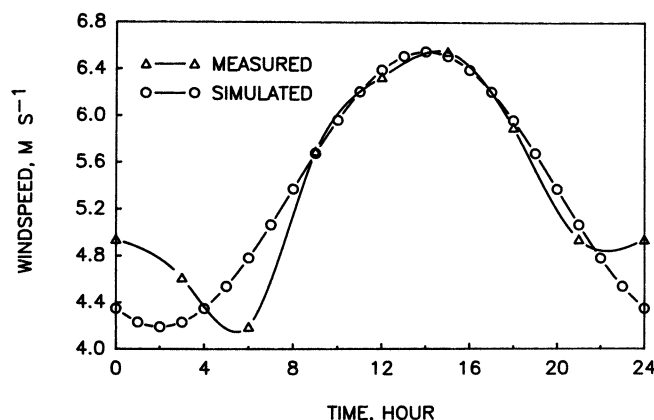


Figure 2—Measured and simulated average hourly annual wind speed compared, Lubbock, TX.

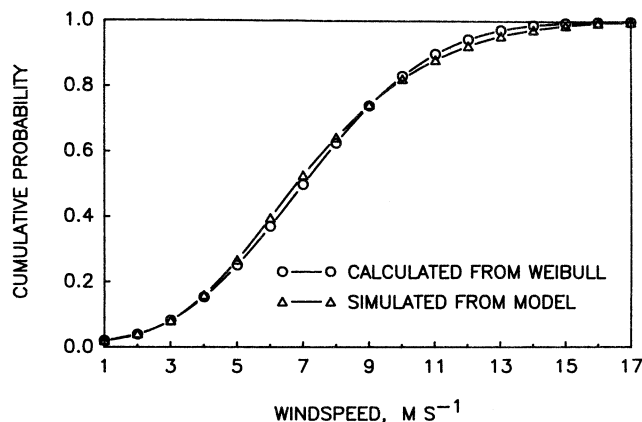


Figure 3—Simulated hourly wind speed compared to Weibull distribution for March, Lubbock, TX. Scale and shape parameters were 8.1 ms^{-1} and 2.7, respectively; percent calm, max/min ratio, and hour of maximum wind speed were 1.7, 1.6, and 15, respectively.

low wind speeds, we could easily force the agreement at low wind speeds by modifying equation 14. Also, if the pattern of daily wind speed variation deviated significantly from sinusoidal, we could replace equation 14 with one that more closely tracks wind speed variation.

Another alternative is to simply use the wind speed returned by equation 9 by each simulation. But this would produce an uncorrelated wind speed sequence. The appropriate procedure will depend on the application of the wind speed information and the consequences of an alternative procedure.

Since superimposing diurnal variation on a daily mean wind speed, drawn from a location wind speed distribution, could introduce an error in the overall distribution, we compared cumulative distributions calculated from Weibull and simulated.

Wind speeds were calculated from equation 14 for $I = 1$ to 24, 1000 times, thus simulating wind speed at 1-hour intervals for 1000 days. This simulated distribution of 24,000 wind speeds was compared to the distribution defined by equation 8. The overall agreement appears excellent (fig. 3), with a slight overestimation in the 5 to 8 m/s wind speeds and a slight underestimation in 10 to 15 m/s wind speed range by the simulation model.

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