Chapter 15 Resource Planning and Evaluation Tools and Worksheets

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Chapter 15 Resource Planning and Evaluation Tools and Worksheets

FL652.1501Water quality, water management, and irrigation evaluation tools

FARM IRRIGATION RATING METHOD (FIRM) The primary goal of the Farm Irrigation Rating Method is to provide the field office with a tool to: (1) plan with the landowner on farm irrigation improvements to achieve a specific level of water management and conservation; and (2) determine the amount of water conserved when a practice or group of measures is installed.

The potential for improving systems for more efficient water use can be determined by field investigations. The real challenge is to develop a viable method for comparing the present irrigation system and management to feasible modifications which result in more efficient irrigation systems and improved management. A good rating system is needed because complete field evaluations are sometimes difficult and require manpower and money which are frequently unavailable. FIRM was developed using published data for most factors and estimates based on field experience for others. FIRM needs to be tested against field trials and complete field evaluations to refine and improve factors used in the system. FIRM is not intended to replace system evaluations but is to be used as a tool in determining how the irrigation system and management can be improved.

FIRM provides a uniform and simple method to analyze on farm irrigation water conservation. It provides good documentation of the effects of change. It can document effects of annual practices or increments of a conservation plan for a farm unit. The method is the product of three elements:

1. The on farm water management – The human element involves decisions which can be scientifically based on measuring water, monitoring soil moisture, and knowing how to operate the irrigation system efficiently. It also involves farmer decisions on a maintenance program, tillage operation, and conservation cropping systems. How the water delivery system is operated also affects decisions on when and how much water to apply. Once a system is in operation, a management plan is needed.

2. The on farm irrigation system – For a sprinkler the key system components are conveyance, uniformity of sprinkler pattern, variation in nozzle pressure, and climatic effect. Key system components for subirrigation are conveyance, uniformity of water table, capacity to maintain the desirable water table, surface slope, and prevention of tailwater loss. Key components for surface system are conveyance, irrigation length, surface slope and prevention of tailwater loss.

3. The potential efficiency of the system - The system “potential efficiency" for an optimally performing unit for the site-specific physical layout can be determined from the attached Table FL15-1. For future conditions, a properly designed and installed system utilizing the latest technology is desired.

The on farm water management element is defined by six factors applicable to either a surface, sprinkler, subirrigation, or microirrigation system. The six management factors:

(1) Md - Use of water flow measuring devices (Fig. FL15-1a)

(2) S - Soil moisture monitoring and scheduling (Fig. FL15-1b)

(3) I - Irrigation skill level (Fig. 1c)

(4) M - Maintenance condition of the system (Fig. FL15-1d)

(5) W - The water delivery constraint (Fig. FL15-1e)

(6) Sc - Soil Condition (Fig. FL15-1f)

The on farm irrigation system element is defined

by selected factors. The factors are:

(1) F - Type of farm conveyance system (Fig. FL15-2)

(2) U - Uniformity of application
- Sprinkler (Fig. FL15-3a)
- Subirrigation (Fig. FL15-3b)
- Crown Flood (Fig. FL15-3c)
- Surface (Fig. FL15-3d)

(3) A - Percent of root zone - Area wetted by microirrigation system emitters on deep, well drained soils (Fig. FL15-4).

(4) D - Water delivery system
- Sprinkler (Fig. FL15-5a)
- Subirrigation (Fig. FL15-5b)
- Crown Flood (Fig. FL15-5c)
- Microirrigation (Fig. FL15-5d)

(5) L - Condition of land surface
- Subirrigation (Fig. FL15-6a)
- Crown Flood (Fig. FL15-6b)
- Surface (Fig. FL15-6c)

(6) T - Tailwater (Fig. FL15-6)

(7) C - Climate Effect (Fig. FL15-8)

FIRM expressed as an equation for an irrigation system where E is potential efficiency.

Sprinkler:

FIRM = E x FUDC x MdSIMWSc

Subirrigation:

FIRM = E x FUDLT x MdSIMWSc

Microirrigation:

FIRM = E x FAD x MdSIMWSc

Surface:

FIRM = E x FULT x MdSIMWSc

An example of how FIRM evaluates a change in the on farm irrigation system and management follows:

For this example, the improvements to a flow through, open ditch subirrigation system were installing an underground pipeline to replace an earthen channel in sandy soil with water table 1.5 ft below delivery ditch hydraulic gradient (F from 0.8 to 1.0); recommended spacing of laterals is being used (U, no change); only 90% of daily peak was being delivered and with improvements in capacity is 100% of daily peak use (D from .95 to 1.0); natural ground varied 0.5 ft but will be leveled (L from 0.95 to 1.0); 30% of water is being lost as tailwater, but a structure for water control will be installed to reuse 55% of tailwater (T from 0.75 to .90); the only change in management will be the installation of observation wells to schedule irrigations and manage water table between planned levels, previously no monitoring was being done (S from 0.90 to 1.0).

Potential Efficiency, E

The potential efficiency is obtained from Table FL15-1. Eighty percent (80%) for a subirrigation system with open channel laterals was used for present and improved.

System Elements

	FxUxDxLxT	Product
Present	0.8 x 1.0 x 0.95 x 0.95 x 0.75 =	0.54
Improved	1.0 x 1.0x 1.0 x 1.0 x 0.9 =	0.90

Management Elements

	MdxSxIxMxWxSc	Product
Present	0.90 x 0.90 x 0.95 x 0.95 x 1.0 x 1.0 =	0.73
Improved	0.90 x 1.0 x 0.95 x 0.95 x 1.0 x 1.0 =	0.81

	Potential Efficiency E	x	System Element FUDLT	x	Management Element MdSIMWSc	=	Farm Irrigation Rating Method FIRM
Present	80%	x	0.54	x	0.73	=	32%
Improved	80%	x	0.90	x	0.90	=	58%

The improvements in system and management should result in an on farm irrigation rating change from 32% to 58%. The FIRM change can be translated into water conserved.

If the average net consumptive use for a normal year is 7.53 inches for potatoes in climatic zone 2, the reduced water use would be:

	Potential Efficiency ac-in./ac		System Element ac-in./ac		Management Element ac-in./ac		Total ac-in./ac
Present	$\frac{7.53}{0.80}$	+	$\left[\frac{7.53}{(.80)(0.54)} - \frac{7.53}{0.80}\right]$	+	$\left[\frac{7.53}{(0.80)(0.54)(0.7)3)} - \frac{7.53}{(0.80)(0.5)}\right]$	=	$\frac{7.53}{0.3154}$
Improved	$\frac{7.53}{0.80}$	+	$\left[\frac{(90)(0.80)}{(0.80)(0.90)} - \frac{7.53}{0.80}\right]$	+	$\left[\frac{7.53}{(0.80)(0.90)(0.81)} - \frac{7.53}{(0.80)(0.9)}\right]$	=	$\frac{7.53}{0.5832}$

Present	9.41	+	8.02	+	6.45	=	23.88
Improved	9.41	+	1.05	+	2.45	=	12.91
Conserved	0.0	+	6.97	+	4.00	=	10.97

The total water conserved during a normal year was computed to be 10.97 inches, with 6.97 inches resulting from system improvements and 4.00 inches achieved by improved management. Similar computations can be made to indicate water conserved for any change in either the system or management element.

A Microsoft (MS) Excel® worksheet titled "FIRM-FL" has been developed to perform the calculations required in the Farm Irrigation Rating Method. The FIRM-FL worksheet can be downloaded from the Florida NRCS home page.

Another example is the conversion of one irrigation system to another as follows:

Potential Efficiency	Present irrigation system: Subirrigation Crown Flood		Improved irrigation system: Microirrigation, spray jet	
E		80%		85%
Management Elements				
Md	None	0.90	None	0.90
S	None	0.90	None	0.90
I	Part time	0.90	Auto	1.00
M	Good	0.95	New	1.00
W	Arranged	0.95	Demand	1.00
Sc		1.00		1.00
Management Element		**0.66**		**0.81**
System Elements				
F	Earthen Canals – WT ≤ 1	0.85	UPS	1.00
U	24” beds – 25’ width	0.95	-------	---
A	-------	---	50%	1.00
D	F&D time 24 hours	1.0	Flow variation ± 5%	1.05
L	Fair – elevation difference 1.0	0.90	-------	---
T	70% is tailwater, 95% reused	0.98	-------	---
System Element		**0.71**		**1.05**
FIRM =	0.80 x 0.66 x 0.71 = 37%		0.85 x 0.81 x 1.05 = 72%	

Exhibit FL15-1 Example - **FARM IRRIGATION RATING METHOD**

Cooperator: ***George Smith*** Location: ***3 mile SW of Anywhere, FL***
County ***Any*** Conservation District: ***All*** Identification No.: ***123***
Field Office: ***Working*** Climatic Zone: ***5*** Water Management District: ***SFWMD***

Farm Name/Field No.	***Jones Field 1***		***Jones Field 2***	
	Present	Improved	Present	Improved
POTENTIAL EFFICIENCY (E) (Table 1)	***80%***	***80%***	***80%***	***85%***
Measuring Devices (Md) Fig. FL15-1a	***0.90***	***0.90***	***0.90***	***0.90***
Soil Moisture Monitoring (S) Fig. FL15-1b	***0.90***	***1.00***	***0.90***	***0.90***
Irrigation Skill (I) Fig. FL15-1c	***0.95***	***0.95***	***0.90***	***1.00***
Maintenance (M) Fig. FL15-1d	***0.95***	***0.95***	***0.95***	***1.00***
Water Delivery (W) Fig. FL15-1e	***1.00***	***1.00***	***0.95***	***1.00***
Soil Condition (Sc) Fig. FL15-1f	***1.00***	***1.00***	***-***	***-***
MANAGEMENT ELEMENT MdxSxIxMxWxSc	***0.73***	***0.81***	***0.66***	***0.81***
Type of Irrigation System	***Subirr Open channel***	***Subirr. Open channel***	***Crown Flood***	***Microirr. spray jet***
Farm Conveyance (F) Fig. FL15-2	***0.80***	***0.80***	***0.85***	***1.00***
Uniformity (U) Fig. FL15-3	***1.00***	***1.00***	***0.95***	***-***
% Root Zone (A) Fig. FL15-4	***-***	***-***	***-***	***1.00***
Delivery (D) Fig. FL15-5	***0.95***	***0.95***	***1.00***	***1.05***
Land Surface (L) Fig. FL15-6	***0.95***	***0.95***	***0.90***	***-***
Tailwater (T) Fig. FL15-7	***0.75***	***0.95***	***0.98***	***-***
Climate Effect (C) Fig. FL15-8	***-***	***-***	***-***	***-***
SYSTEM ELEMENT	***-***	***-***	***-***	***-***
Sprinkler – F x U x D x C				
Subirrigation – F x U x D x L x T	***0.54***	***0.90***	***0.71***	
Microirrigation – F x A x D				***1.05***
Surface – F x U x L x T				
FIRM = E x Mgt. Element x Sys. Element	***32%***	***58%***	***37%***	***72%***
Normal Net Irrigation Requirement, inches NNIR	***7.53***		***14.47***	
Gross Irrigation Requirement, inches NNIR ÷ FIRM	***23.88***	***12.91***	***39.11***	***20.10***
Water Conserved, inches Present – Improved	***10.97***		***19.01***	
Area Irrigated, acres	***79***		***58***	
Total Water Conserved, ac-in	***867***		***1,103***	

FIRM has its greatest validity in evaluating change, not in estimating the absolute value of on farm irrigation efficiency. It would be preferable to call the end product a rating of water use, present and improved. The FIRM can provide an approach to compare the present and future on farm irrigation consistently by using a standard set of system and management modifiers.

FIRM provides a relative rating. It is the product of up to twelve management and system factors to rate consistently from one location to another the effectiveness of irrigation practices. When a potential efficiency is selected for a specific field and irrigation system, the rating will evaluate the difference between the gross volume of farm delivery and the net consumed by the plant. Additional evaluations are needed for special water use to determine how efficient the system will apply water for frost protection, waste utilization, fertigation, or chemigation as examples. FIRM represents typical conditions and will only provide a rating of change. It will not substitute for detailed irrigation trials and evaluations.

Summary

FIRM is a valuable tool for identifying the increments of change in on farm irrigation water use that can result from improvement in system or management elements. FIRM can be translated into water conservation terms, such as reduced demands for water, reduced losses and waste, and amount of water conserved.

Exhibit FL15-2 - Definitions

Management Factors

Md - Water Measurement. Water must be measured to each field for optimum irrigation water management. The measurement at the farm delivery point can be translated to each field if the water is not split.

S - Soil Moisture/scheduling. The soil moisture deficit in the root zone must be measured (monitored) and irrigations scheduled to obtain good water management.

I - Irrigation Skill. Good management requires an operator trained in how to apply the water. An automated system can be properly managed to substitute for a trained irrigator. More mechanical skill will be required to manage a sprinkler or microirrigation system.

M - Maintenance. A system must be maintained in order to be managed at its potential. Nozzles on sprinklers have to be replaced; fields need to be releveled; structures for water control have to be replaced when they deteriorate; spray emitters must be unplugged and maintained in proper position to obtain desired wetted area; and system leaks must be repaired.

W - Water Delivery. To properly irrigate the crop, water must be available when needed at the rate for optimum application. Uncontrolled water is not normally available all season, every year. In short supply areas there is probably lower efficiency than in full supply areas. If you are on a rotation and receive water on a preset interval, whether you need it or not, there is a tendency to over irrigate during part of the season and not have sufficient water during peak use periods. An arranged system is one where you can request water from an irrigation company. Usually there is some storage. There can be restrictions, fixed operation, or limited rates during the season which reduces efficiency. A demand system with full control of when and how much is ideal for good water management.

Sc - Soil Condition. Conservation tillage, no till, crop residue use, and a conservation cropping system are management tools to improve soil conditioning and facilitate better irrigation on cropland. Crop residues on the soil surface increase intake, reduce runoff, and reduce water lost by evaporation from the soil surface.

Exhibit FL15-2 - Definitions (continued)

Irrigation System Factors

F - Conveyance. On farm conveyance system losses are defined by type of conveyance. Earthen ditch losses are estimated based on soil permeability and water table position.

U - Uniformity of application. The degree of application uniformity is a controlling factor in obtaining desired results from irrigation.

A - Area wetted. Percent of root zone wetted affects how effectively crops utilize the water applied with microirrigation.

D - Delivery system. Variations in pressure and flow rates affect the uniformity of water applied in the system.

L - Land surface. Surface roughness is a very major factor influencing the performance of subirrigation and surface irrigation methods. Laser leveling and land leveling with proper irrigation length will improve irrigation application, particularly uniformity.

T - Tailwater. Percent of loss depends on system design, percent recaptured, and system operation.

C - Climatic effect. Spray type, wind speed, humidity and temperature affects sprinkler evaporation and drift loss.

LOCAL CRITERIA

Conditions typical to your area should be identified. In addition, identify conditions unique to the area or outside normal operations. For example, open channels used for conveyance in the muck area will normally not have excessive seepage loss although the permeability of muck may be rapid. The area normally has a high water table and the seepage loss contributes to maintaining the water table, so a F factor of 0.85 may be appropriate. Wind and evaporation would not affect below canopy sprinklers as greatly as above tree canopy sprinklers. Tailwater factor is based on percent of water lost as tailwater and the percent reused.

Table FL15-1 - System Potential Efficiencies (E)

Sprinkle Irrigation	**Percent**
Fixed Lateral (solid set)	75
Traveling Gun (gun type or boom)	65
Periodic Move gun type or boom sprinklers	60
Center-Pivot, Standard	85
Linear (lateral) Move	87
Periodic Move Lateral	75
LEPA – center pivot and linear move	95

Subirrigation	**Percent**
Underground Conduit	85
Open Ditch (Irrigating Laterals or Furrows)	
Flow Through	80
Backup	75
Crown Flood	80

Microirrigation	**Percent**
Spray Emitters	85
Point Source Emitters	90
Line Source Emitters	90

Surface Irrigation	**Percent**
Graded Furrow	80
Level Furrow	85

Table FL15-2 Potential Evaporation Rate (Inches Per Day)

Month	**Climatic Zone**						
	1	2	3	4	5	6	7
January	0.06	0.07	0.09	0.09	0.10	0.10	0.11
February	0.09	0.11	0.12	0.12	0.13	0.13	0.14
March	0.12	0.14	0.14	0.14	0.16	0.16	0.17
April	0.16	0.17	0.19	0.19	0.19	0.19	0.19
May	0.19	0.19	0.20	0.20	0.19	0.19	0.19
June	0.19	0.20	0.20	0.20	0.18	0.18	0.18
July	0.18	0.19	0.19	0.18	0.18	0.18	0.18
August	0.17	0.17	0.17	0.17	0.18	0.17	0.17
September	0.15	0.15	0.15	0.16	0.15	0.15	0.15
October	0.11	0.11	0.13	0.14	0.14	0.14	0.14
November	0.08	0.09	0.10	0.11	0.12	0.11	0.12
December	0.06	0.07	0.08	0.08	0.10	0.10	0.11

Table FL15-3 -Tabulation of Evaluating Factors - Management

Water Measurement	**Md Factor**
None	0.90
Farm Delivery Point	0.98
Each Field	1.00

Soil Moisture Scheduling	**S Factor**
None	0.90
Soil Moisture Monitoring or Scheduling	0.95
Soil Moisture Monitoring and Scheduling	1.00

Irrigation Skill	**I Factor**
Part time	0.90
Full time, Untrained	0.95
Full time, Trained/Automated	1.00

Maintenance	**M Factor**
Poor	0.90
Fair	0.925
Good	0.95
Excellent	0.975
New	1.00

Water Delivery	**W Factor**
Uncontrolled	0.70
Rotation	
Moderate frequency	0.74
Moderate amount	0.76
Arranged	
Fixed duration	0.80
Restricted	0.84
Limited rate	0.95
Demand	
Limited rate	0.98
Unrestricted	1.00

Soil Condition

Tillage	Residue Soil Surface Cover	**Sc Factor**
Clean	0	0.95
Crop Residue	30%	1.00
Conservation	30% +	1.04
No till	30%+	1.10
All other land uses		1.00

Table FL15-3 -Tabulation of Evaluating Factors – System (Continued)

Farm Conveyance	**F Factor**
Underground Pipeline - Sound	1.00
Underground Pipeline – System Leaks	0.95
Portable Pipeline	0.95
Concrete Lined Channels	0.95
Earthen Channels in Soils with:	
Very slow permeability	0.85
Sandy soil with water table below H.G. < 1 ft.	0.85
Slow permeability	0.75
Sandy soil with water table below H.G. from 1 to 2 ft	0.75
Moderately slow permeability	0.65
Sandy soil with water table > 2.0 ft below H.G	0.65
Moderate permeability	0.55
Rapid permeability	0.25

Uniformity of Application

Sprinkler Nozzle selection and spacing [1/]

Uniformity, Percent	**U Factor**
85 or greater	1.00
80	0.95
75	0.90
70	0.85
65	0.75

[1/] All sprinkler spacings which meet the practice standard for Sprinkler Irrigation Systems (Code 442) may be assumed to have a U Factor of 1.0.

a. Center Pivot and Lateral-Move Systems - Use local test data on distribution uniformity

$$DU = \frac{\text{Average Weighted-Low Quarter Catch}}{\text{Average Weighted Catch.}}$$ and select representative value from Fig. FL15-3a

b. Gun or Traveling Sprinklers - Use local test data and manufacturer's data and select the representative value from Fig FL15-3a.

c. Fixed lateral and Periodic-Move Systems - Select Cu % from Tables 11-9 to 11-12, NEH, part 623, Irrigation, Chapter 11, manufacturer's data when available, or from local test data. Based on the CU % select the representative value from Fig. FL15-3a.

Table FL15-3 -Tabulation of Evaluating Factors – System (Continued)

Subirrigation

Spacing of irrigation laterals	**U Factor**
Recommended spacing	1.00
Fair spacing (1.5 x Rec. spacing)	0.85
Poor spacing (2.0 x Rec. spacing)	0.60

Subirrigation-Crown Flood

Bedding				**U Factor = HF x WF**
Bed Height (Inches)	HF	Bed Width (Feet)	WF	[1/]
30	1.00	< 60	1.00	[1/]
24	0.95	80	0.90	[1/]
18	0.90	100	0.80	[1/]
12	0.85	> 100	0.70	[1/]

[1/] Multiply HF x WF to obtain the U factor.

Surface

Length of Irrigation Run	**U Factor**
Designed Length	1.00
1.5 x Designed Length	0.85
2.0 x Designed Length	0.60

Area Wetted (Pw) Percent Area Wetted (well drained soils) of the root zone [1/]

Tree & Shrub Crops	Field Crops	**A Factor**
50 or greater	80 or greater	1.00
40	70	0.95
30	60	0.89
20	50	0.80

[1/] See NEH, Part 623, Irrigation, Chapter 7, page 22 for methods of determining Pw.

On soils (flatwoods) with water table depths which provide water to plants by capillary rise (upflux) use A = 1.00 to 0.95. Where water table is not maintained, use the above.

Table FL15-3 -Tabulation of Evaluating Factors – System (Continued)

Delivery System

Sprinkler

Pressure variance at sprinkler nozzle as a percentage of average pressure	**D Factor**
20% or less	1.0
30%	0.95
40%	0.90

Subirrigation

Percent of peak use that can be delivered daily considering efficiency of system	**D Factor**
100%	1.0
90%	0.95
80%	0.90
70%	0.85

Subirrigation-Crown Flood

Time required to flood and drain the application depth		
Flood Time (Hrs)	Draining Time (Hrs)	**D Factor**
24	24	1.0
36	36	0.90
48	48	0.80

Microirrigation

Variance of emitter discharge rates as a percentage of the average	**D Factor**
± 5	1.05
±10	1.00
±15	.95
±20	.90

Table FL15-3 -Tabulation of Evaluating Factors – System (Continued)

Land Surface

Subirrigation

Variation of normal ground along the irrigation lateral in feet	**L Factor**
Level - 0.25	1.00
Uniform - 0.50	0.95
Poor - 0.75	0.85
Rough - 1.00	0.75

Subirrigation-Crown Flood

Variation in elevation on bed crowns in unit irrigated simultaneously in feet	**L Factor**
Level -0.5	1.00
Fair -1.0	0.90
Poor -1.5	0.80
Rough -2.0	0.70

Surface

Land slope and condition	**L Factor**
Precision grades - Laser leveled	1.02
Precision grades - Land leveled	1.00
Essentially uniform - slope increasing or decreasing	0.95
Fairly uniform - steepest slope less than twice the flattest	0.90
Rough - Reverse grades and ponding	0.85

Tailwater	**T Factor**
No tailwater reused	1.05 - (0.01)(TW1)
Tailwater reused	$\frac{(TW1)\ (TWR)}{10{,}000} - (0.0105)(TW1) + 1.05$

TW1 = Tailwater loss as percent of water applied (whole number)
TWR = Percent tailwater reused (decimal)
Note: T shall not be greater than 1.0

Climatic Factor	**C Factor**
Daily potential evapotranspiration Rate (inches/day)	Read from Fig. 8

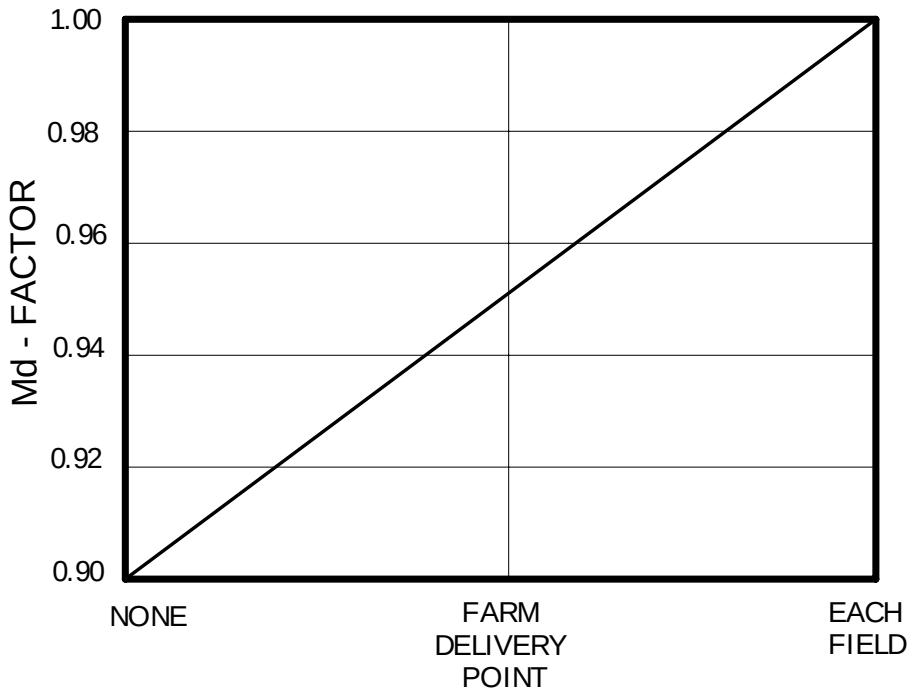


Figure FL15-1a – Measuring Device Factor, Md

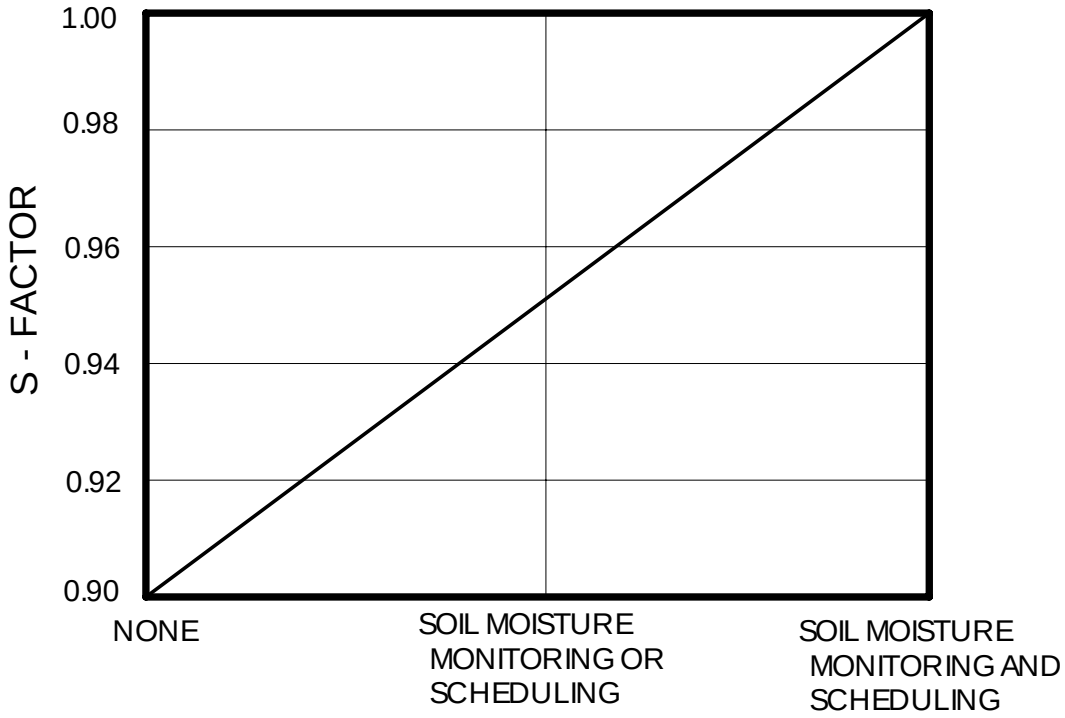


Figure FL15-1b – Soil Moisture/Scheduling Factor, S

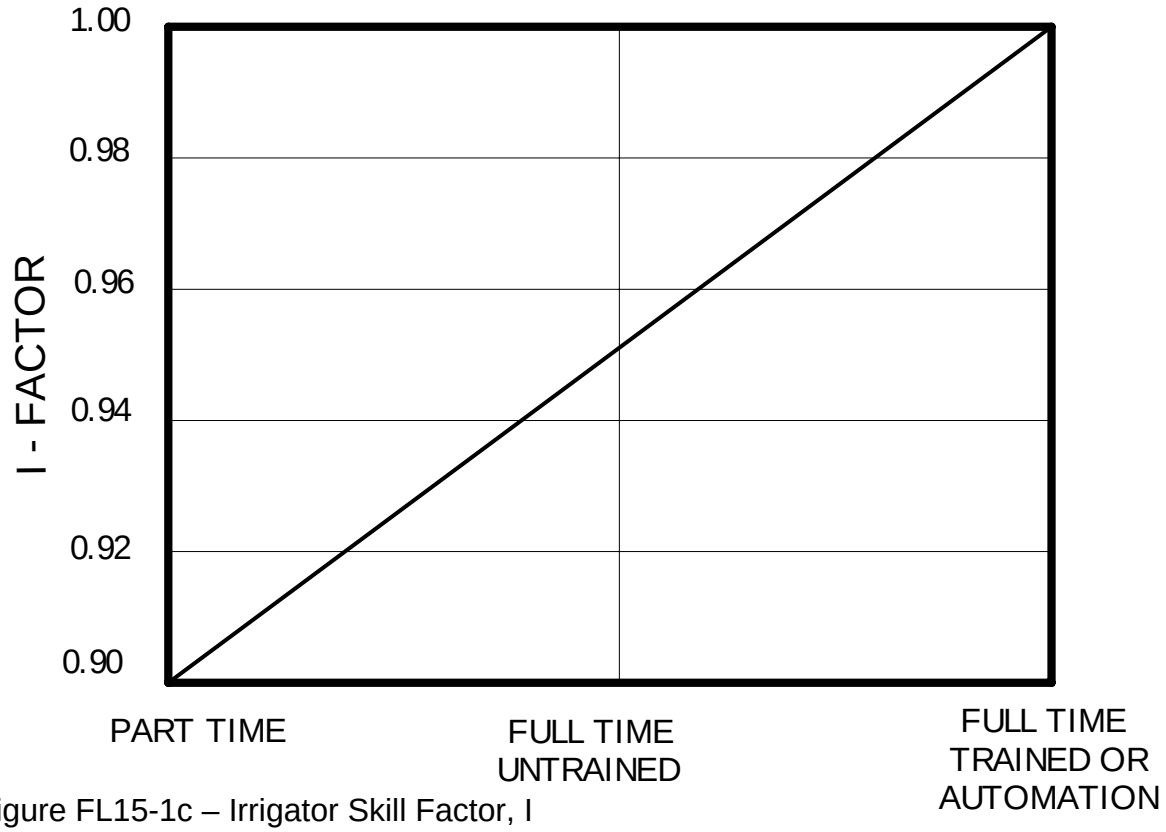


Figure FL15-1c – Irrigator Skill Factor, I

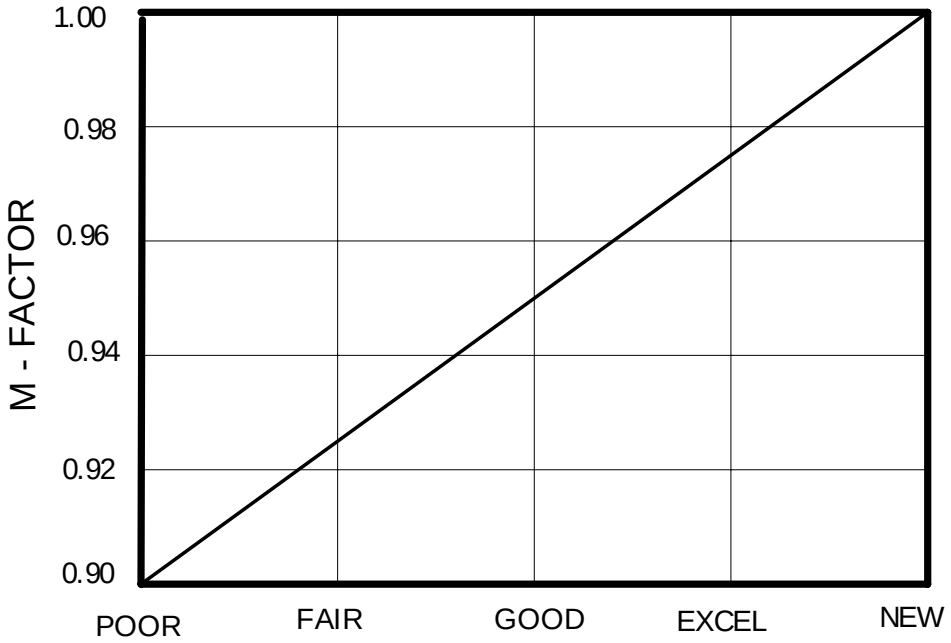


Figure FL15-1d – Maintenance Factor, M

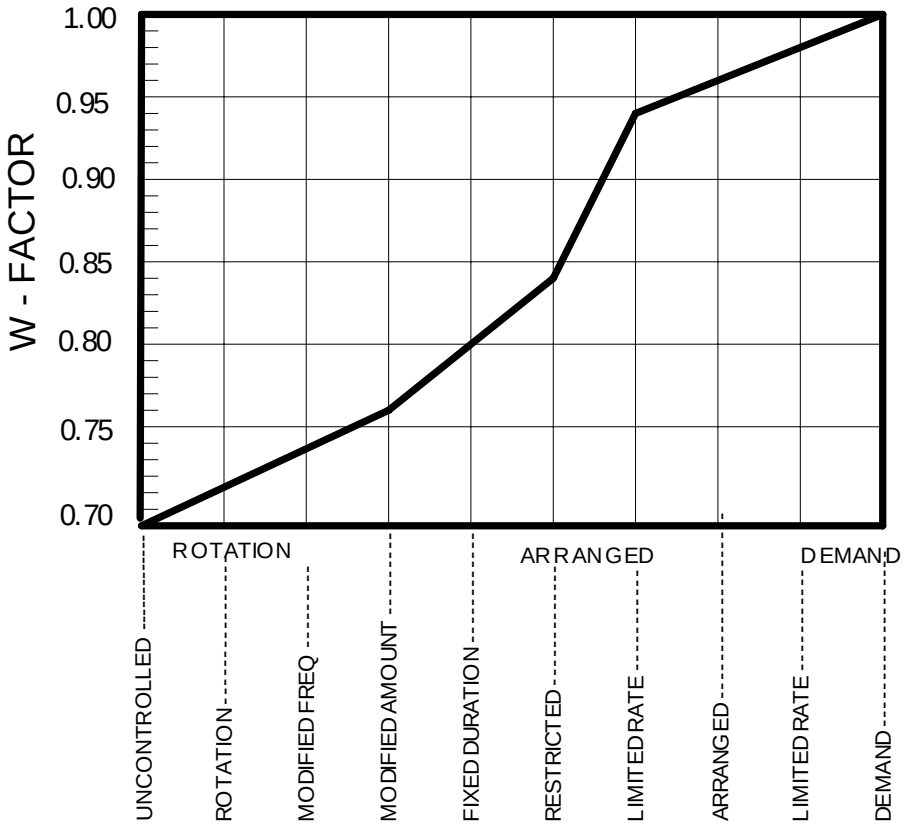


Figure FL15-1e – Water Delivery Factor, W

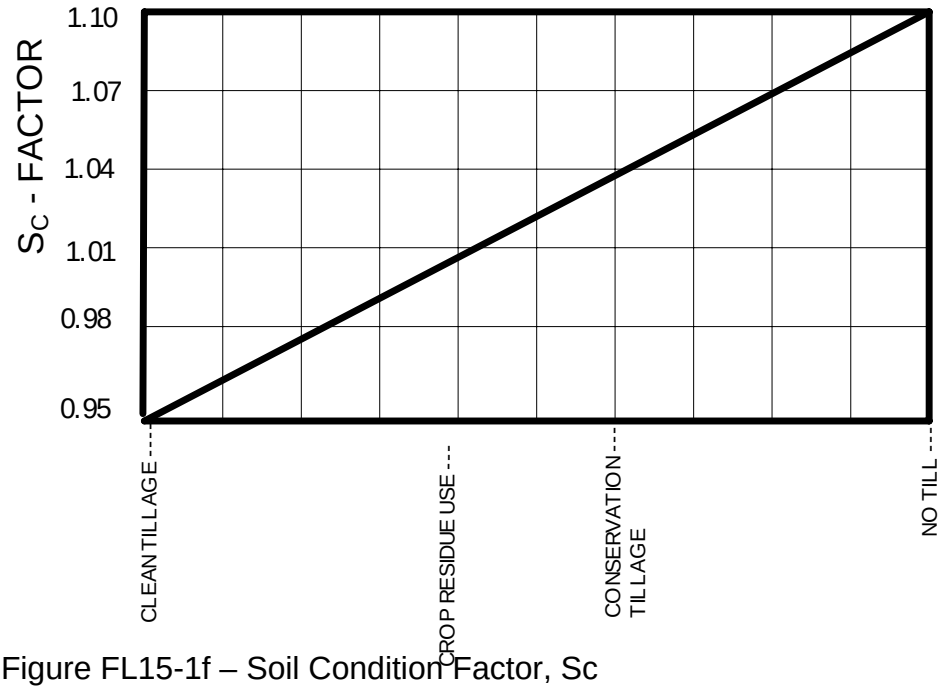
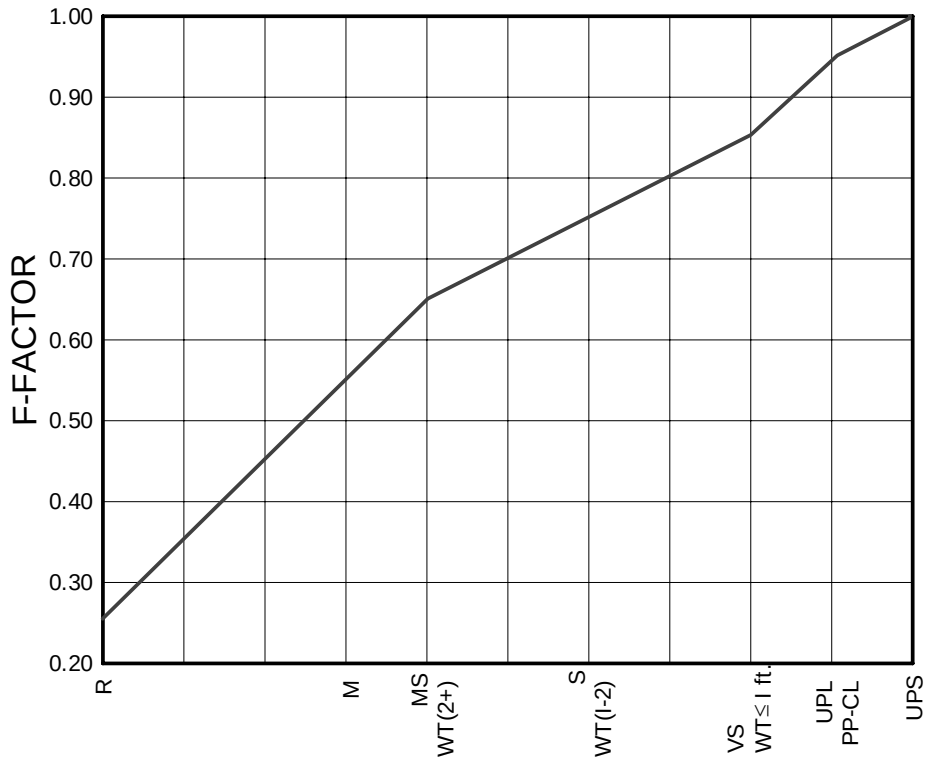


Figure FL15-1f – Soil Condition Factor, Sc



UPS – Underground pipeline, sound
UPL - Underground pipeline, system leaks
PP- Portable pipe
CL – Concrete lined channel

Earthen Channels

VS – Very slow permeability
WT ≤ 1 – Sandy soil with water table below hydraulic gradeline (HG) 1 foot or less
S - slow permeability
WT (1 to 2) - Sandy soil with water table below hydraulic gradeline (HG) between 1 and 2 feet
MS – Moderately slow permeability
WT (2 +) – Sandy soil with water table below hydraulic gradeline (HG) 2 feet or more
M- Moderate permeability
R - Rapid permeability

Figure FL15-2 – Farm Conveyance Factor, F

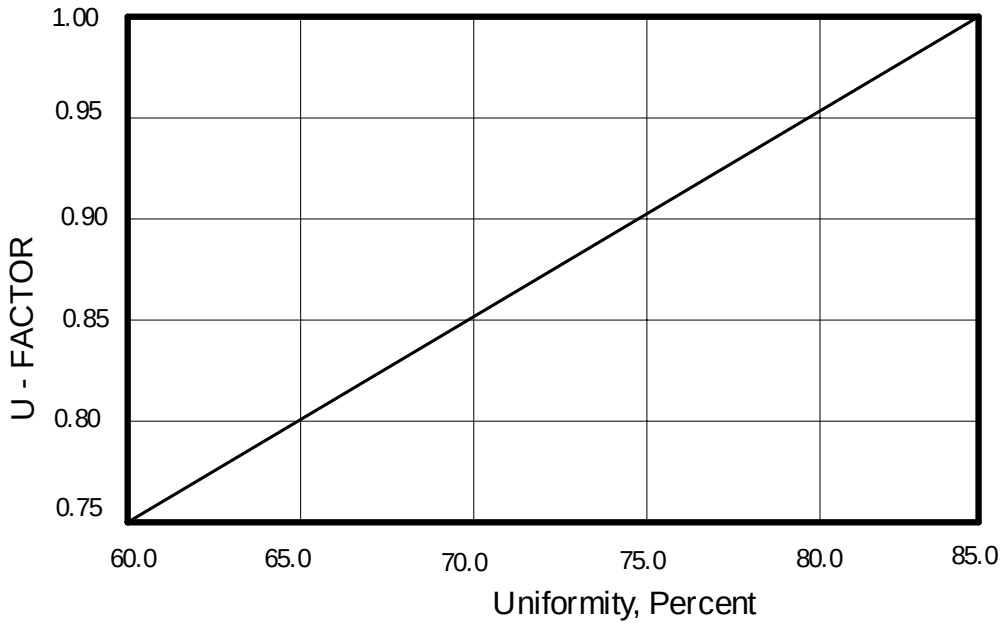


Figure FL15-3a – Uniformity Factor, U for Sprinkler Irrigation

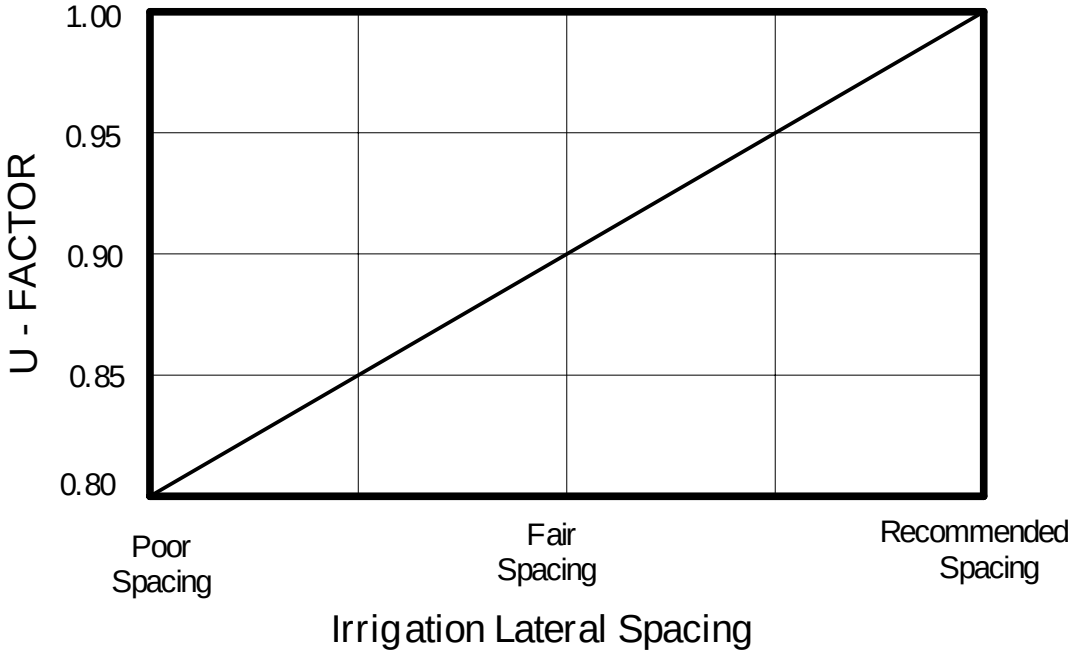


Figure FL15-3b – Uniformity Factor, U for Subirrigation

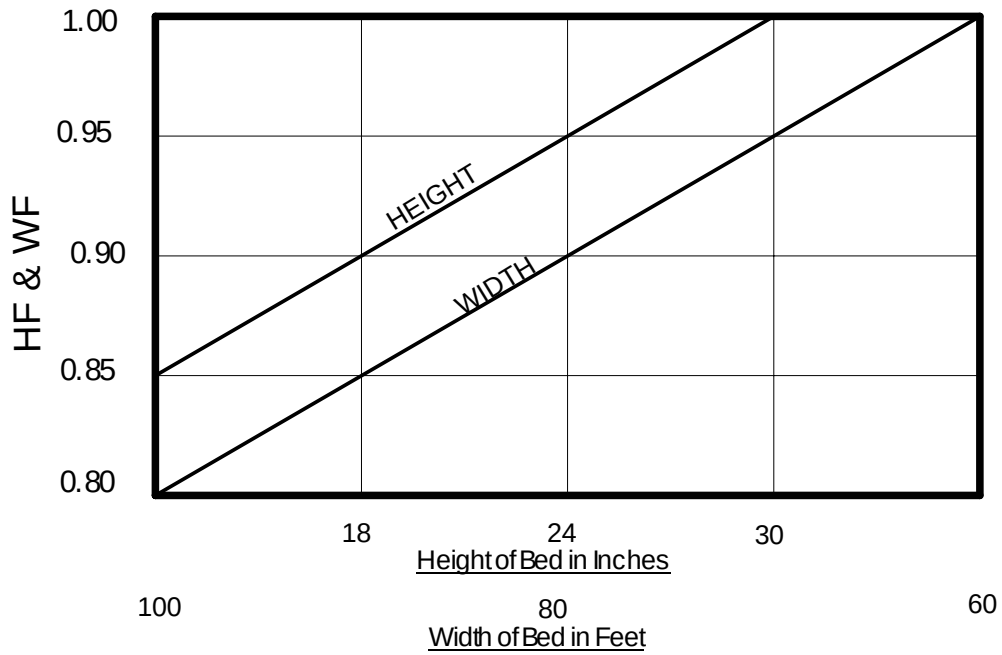


Figure FL15-3c - Uniformity Factor, U for Crown Flood = HF x WF

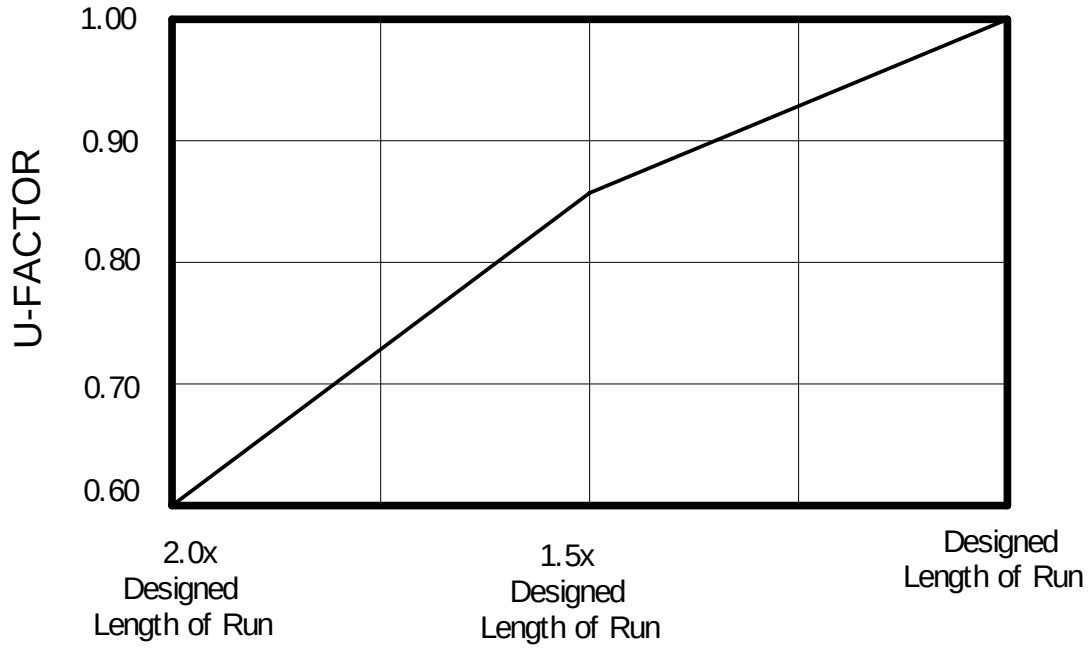


Figure FL15-3d - Uniformity Factor, U for Surface Irrigation

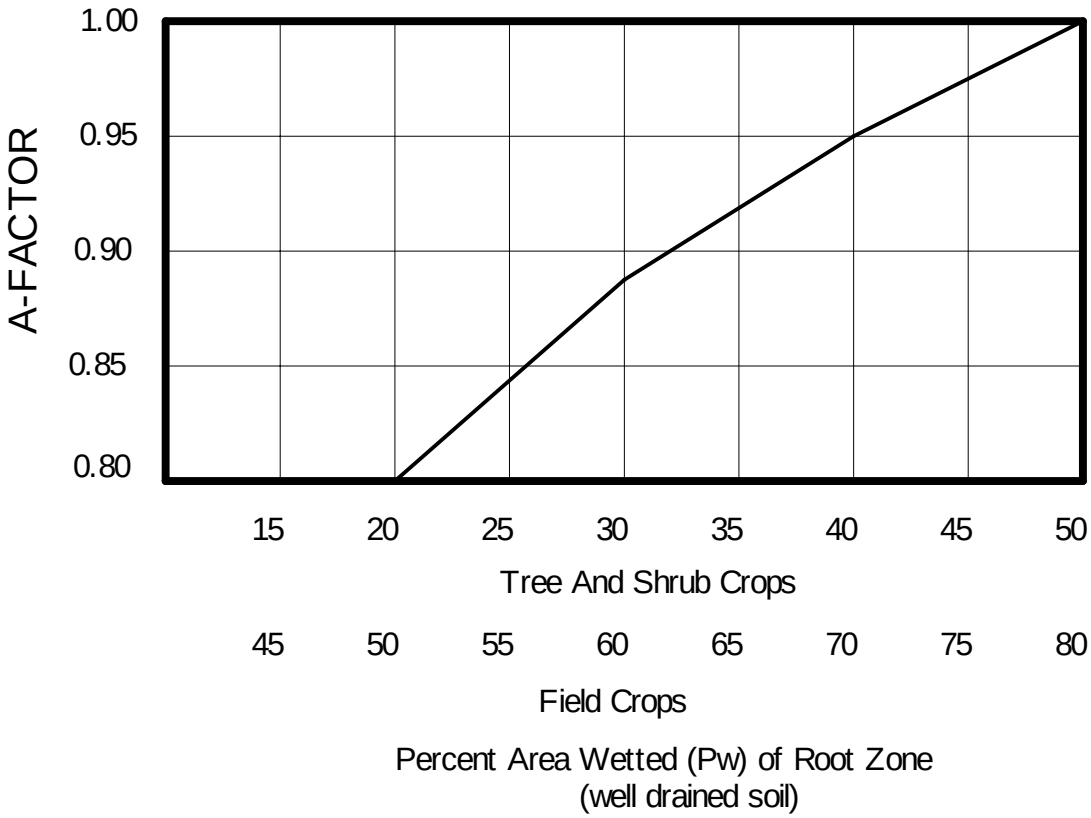


Figure FL15-4 – Area Wetted, A

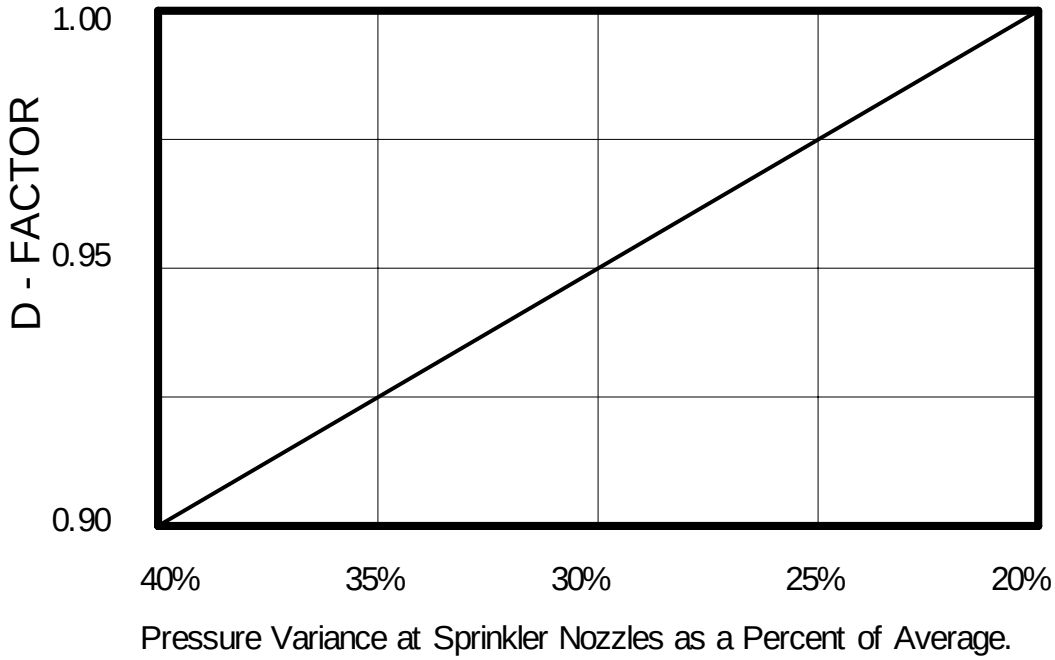


Figure FL15-5a – Delivery factor, D for Sprinkler

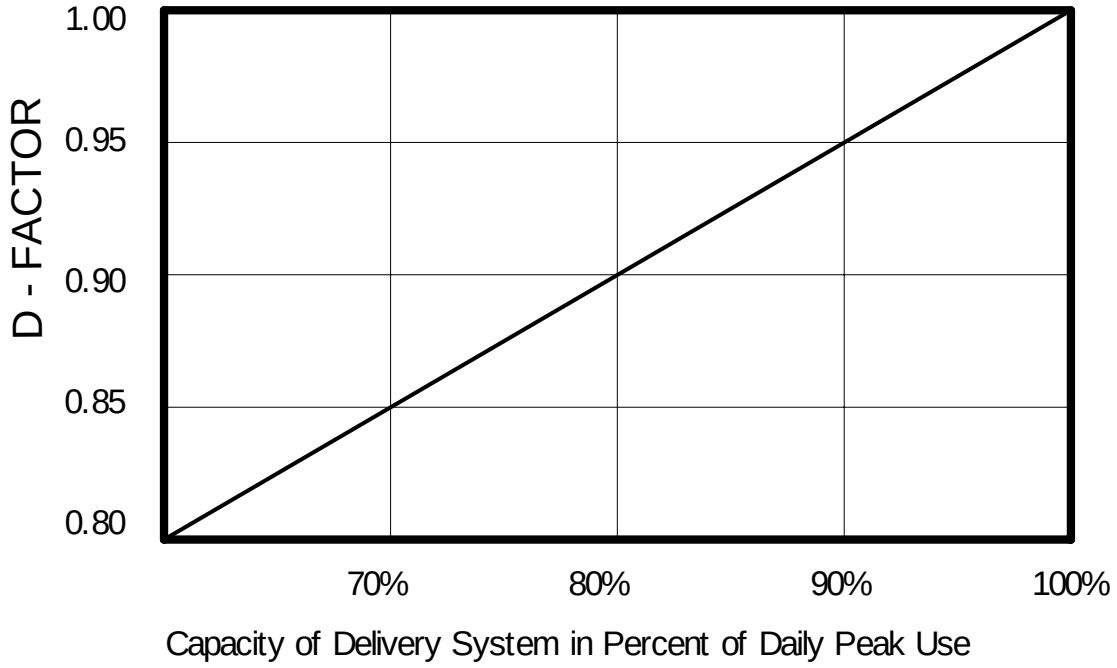


Figure FL15-5b - Delivery factor, D for Subirrigation

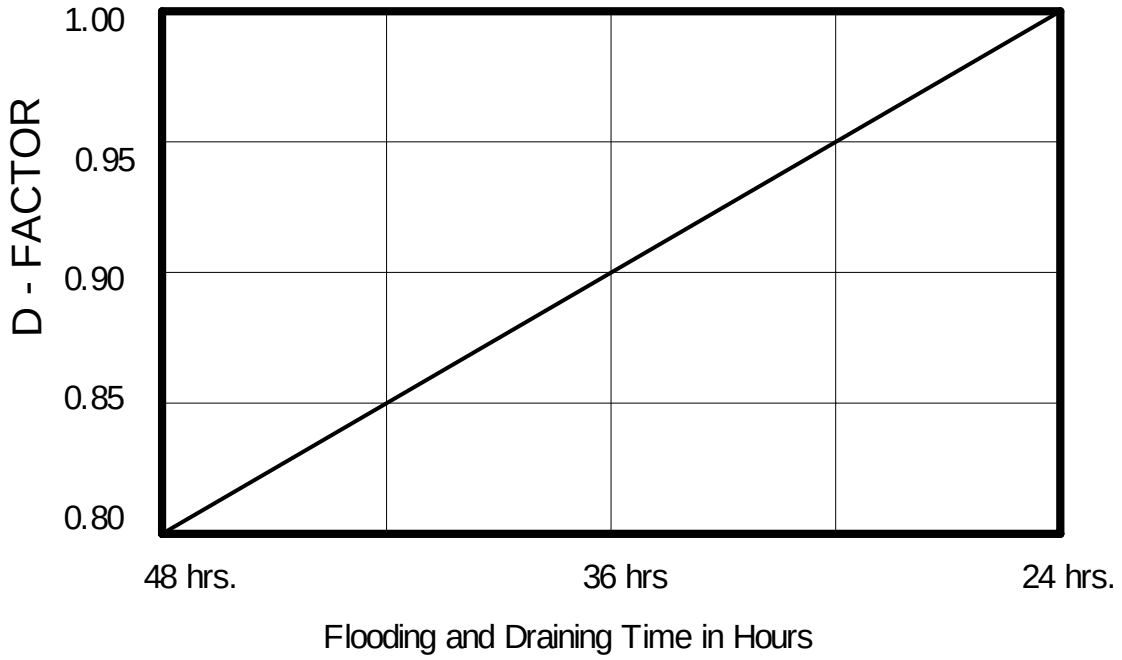


Figure FL15-5c - Delivery factor, D for Crown Flood Irrigation

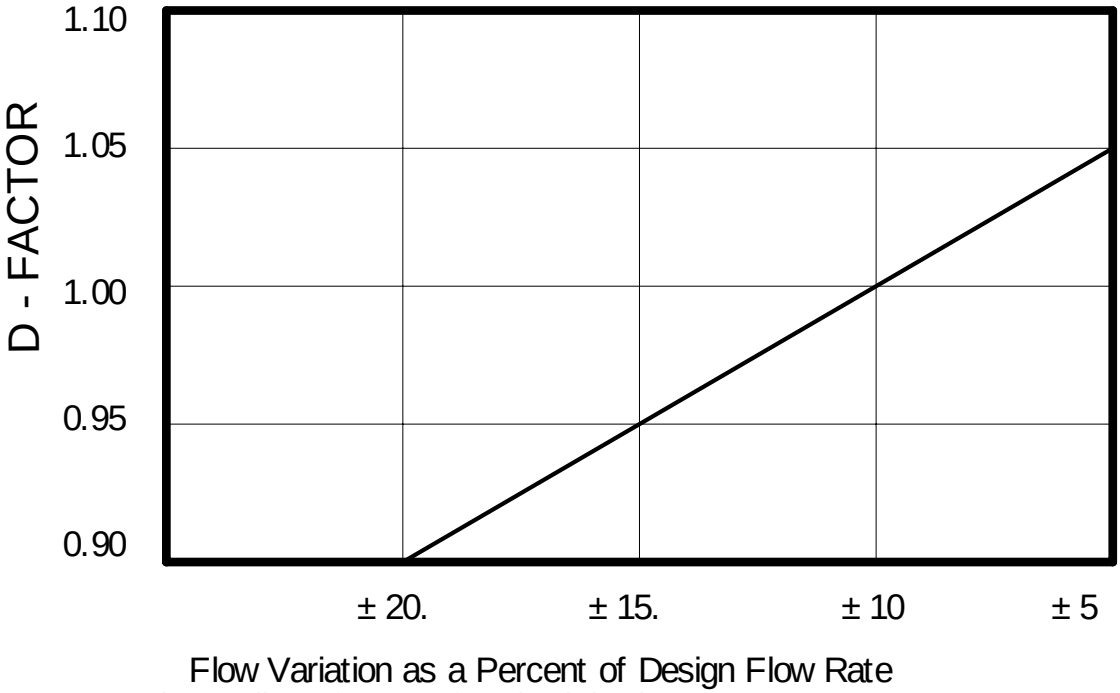


Figure FL15-5d - – Delivery factor, D for Microirrigation

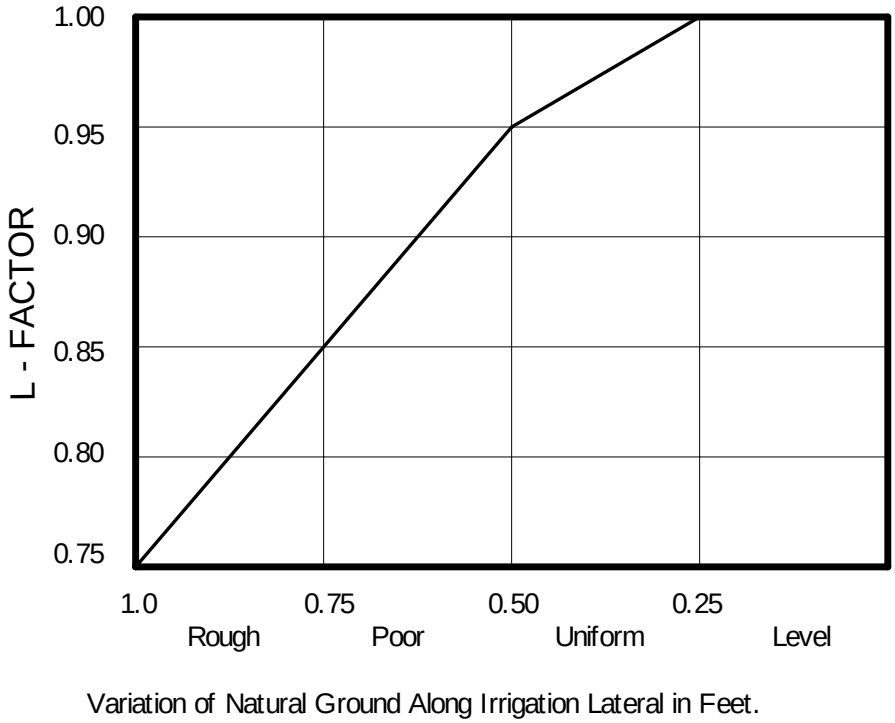


Figure FL15-6a – Land Surface Area Factor, L for Subirrigation

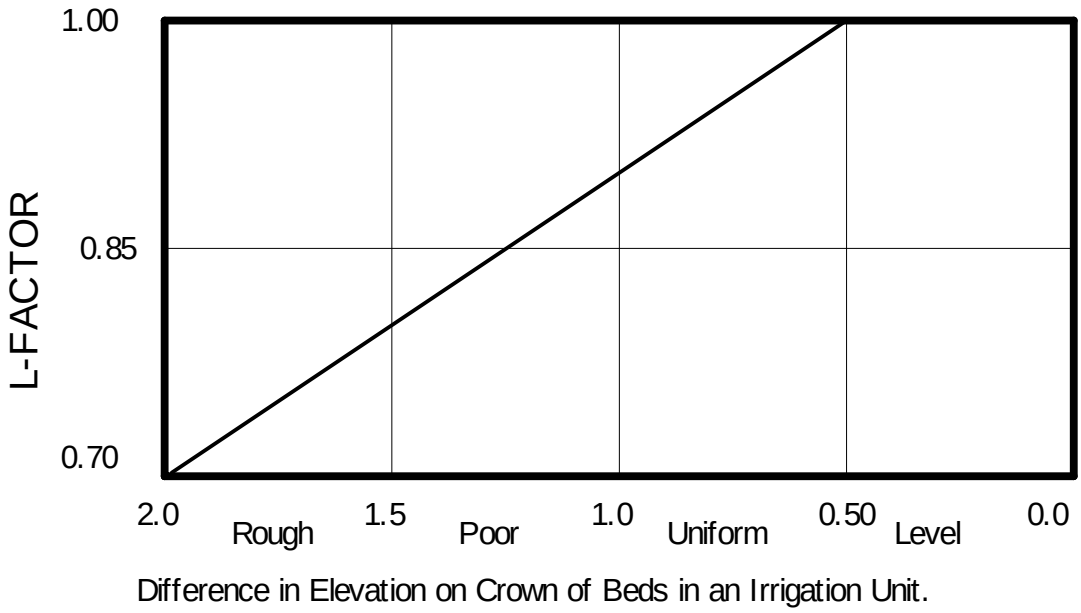


Figure FL15-6b – Land Surface Area Factor, L for Crown Flood

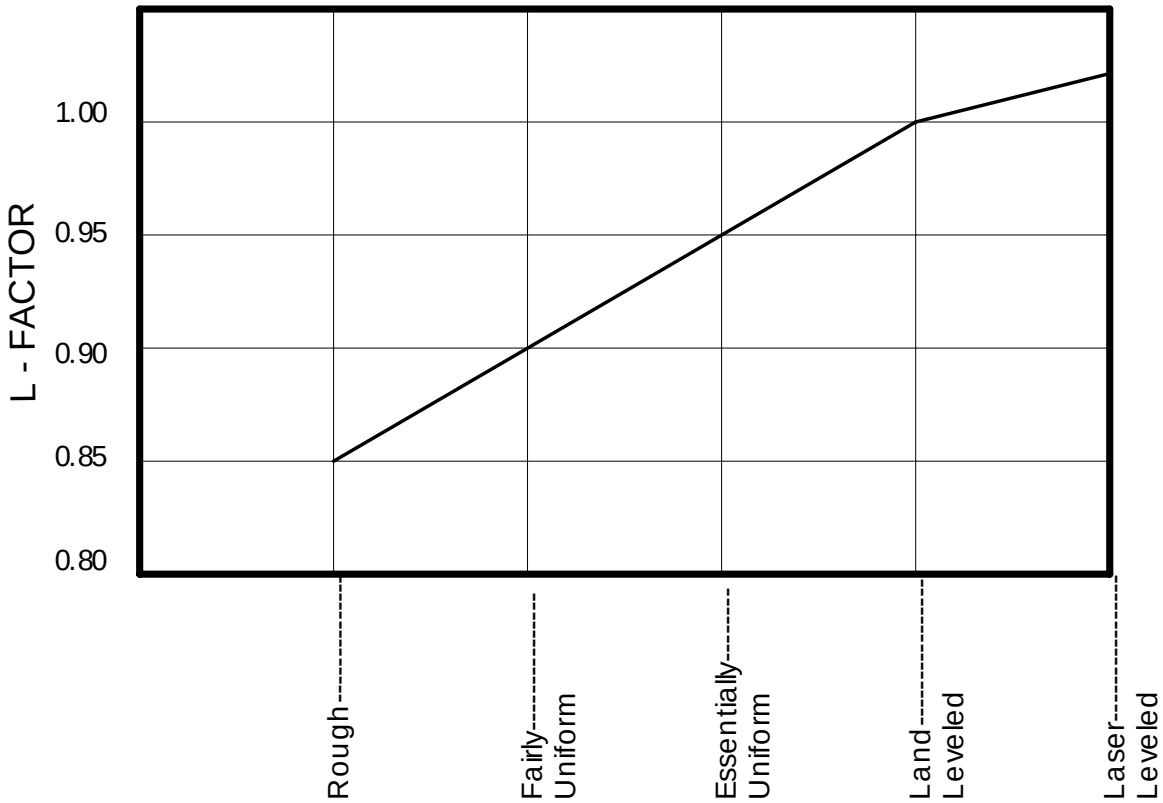


Figure FL15-6c – Land Surface Area Factor, L for Surface Irrigation

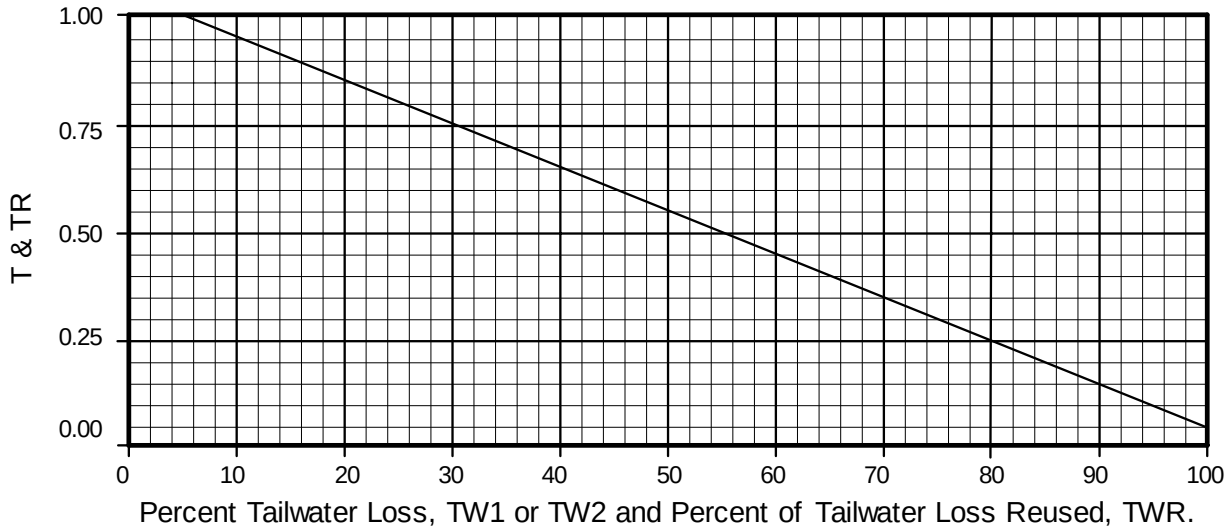


Figure FL15-7 – Tailwater Factor, T

Example:

60 % of water applied becomes tailwater loss, TW1 and is not reused. From Figure 7 for TW1, T = 0.45

Water control structures are installed which reduce tailwater loss to 40%. From Figure 7 for TW = 40%, T = 0.65

A tailwater return system is installed which reuses 80% of tailwater, TWR. From Figure 7, for TWR = 80%, the tailwater reuse factor, TR = 0.25. The revised percent of tailwater loss, TW2 = (TW1) (TR) = (40%) (0.25) = 10%. From Figure 7 for TR2 = 10%, T = 0.95

Where T = Tailwater Factor
TW1 = Tailwater loss as a percent of water applied
TWR = Percent of tailwater reused
TR = Tailwater reuse factor
TW2 = Tailwater loss as a percent of water applied, corrected for reuse

Figure FL15-8 – Climatic Effect

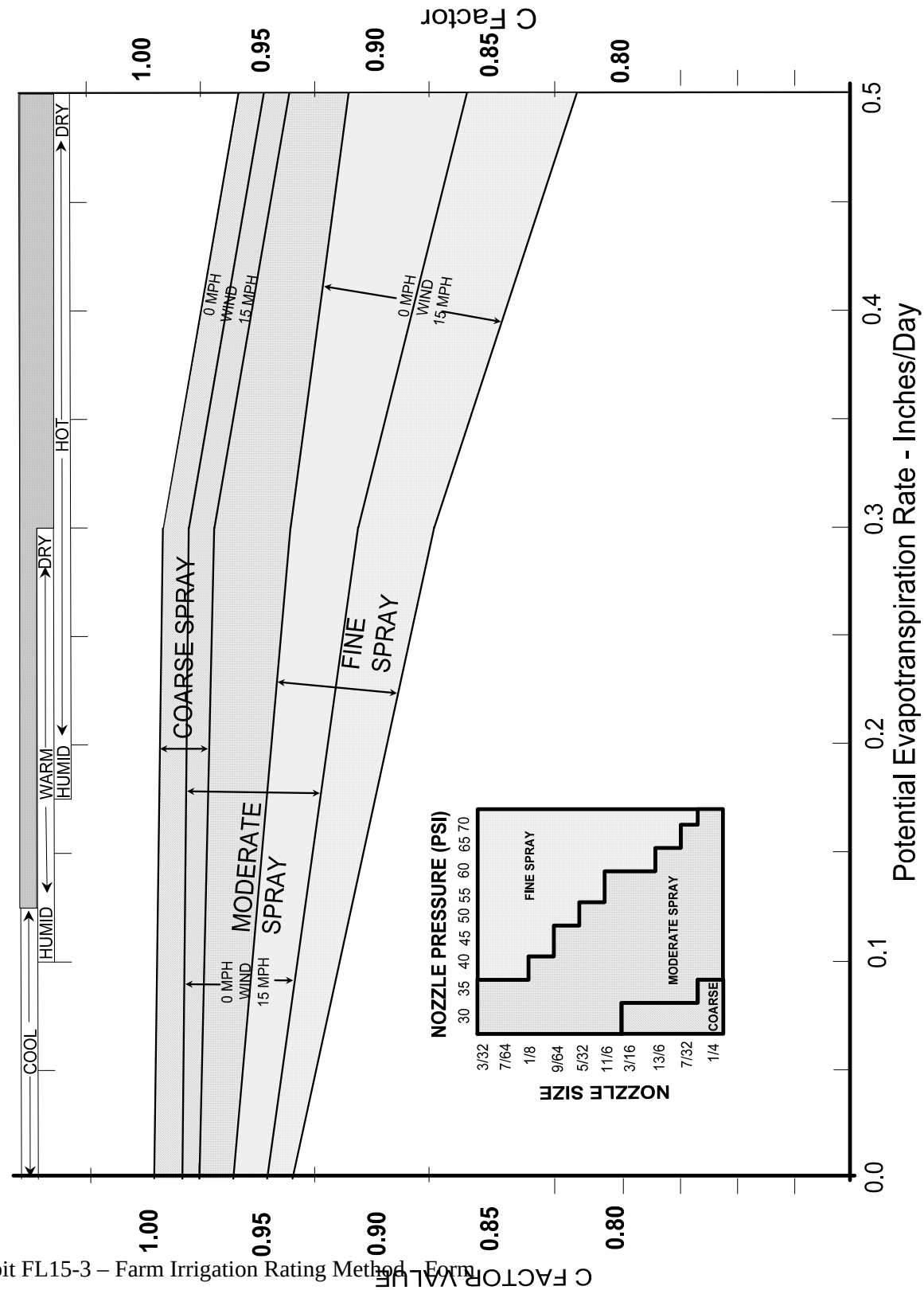


Exhibit FL15-3 – Farm Irrigation Rating Method – Form

FARM IRRIGATION RATING METHOD

Cooperator: _____ Location: _____

County: _____ Conservation District: _____ Identification No.: _____

Field Office: _____ Climatic Zone: ____ Water Management District: _____

Farm Name/Field No.				
	Present	Improved	Present	Improved
POTENTIAL EFFICIENCY (E) (Table 1)				
Measuring Devices (Md) Fig. FL15-1a				
Soil Moisture Monitoring (S) Fig. FL15-1b				
Irrigation Skill (I) Fig. FL15-1c				
Maintenance (M) Fig. FL15-1d				
Water Delivery (W) Fig. FL15-1e				
Soil Condition (Sc) Fig. FL15-1f				
MANAGEMENT ELEMENT MdxSxIxMxWxSc				
Type of Irrigation System				
Farm Conveyance (F) Fig. FL15-2				
Uniformity (U) Fig. FL15-3				
% Root Zone (A) Fig. FL15-4				
Delivery (D) Fig. FL15-5				
Land Surface (L) Fig. FL15-6				
Tailwater (T) Fig. FL15-7				
Climate Effect (C) Fig. FL15-8				
SYSTEM ELEMENT				
Sprinkler – F x U x D x C				
Subirrigation – F x U x D x L x T				
Microirrigation – F x A x D				
Surface – F x U x L x T				
FIRM = E x Mgt. Element x Sys. Element				
Normal Net Irrigation Requirement, inches NNIR				
Gross Irrigation Requirement, inches NNIR ÷ FIRM				
Water Conserved, inches Present – Improved				
Area Irrigated, acres				
Total Water Conserved, ac-in				