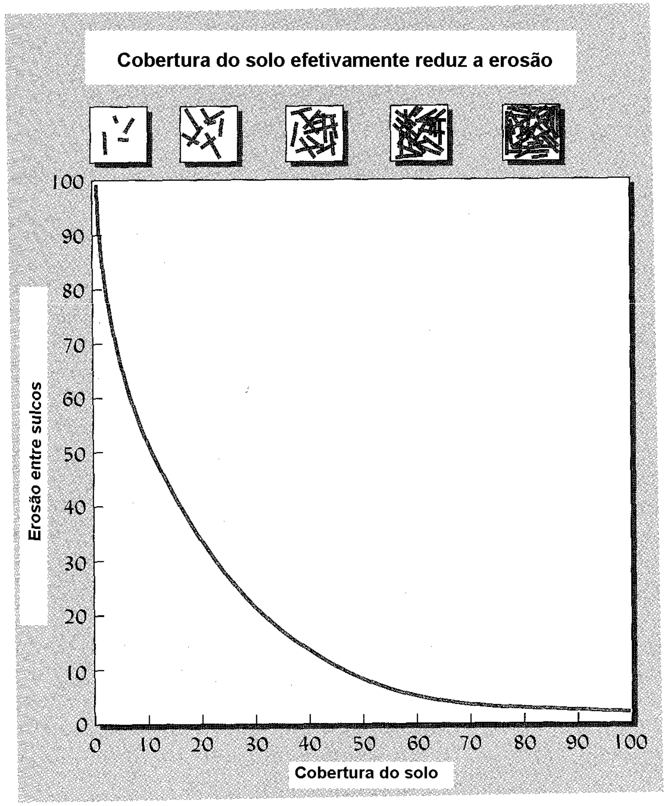
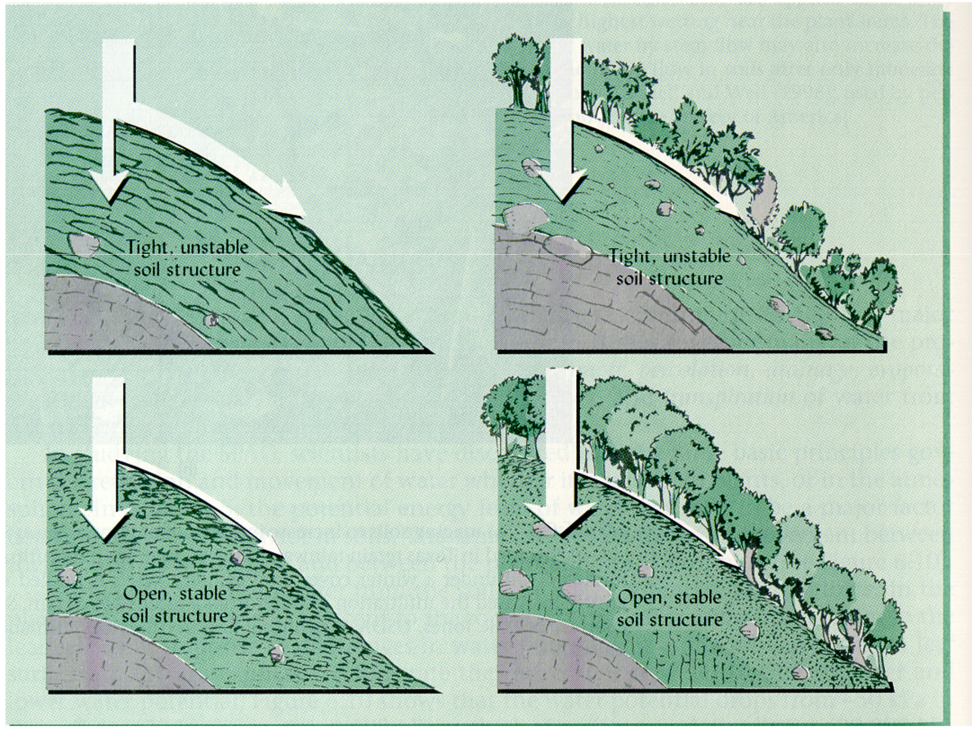
Controle da erosão – práticas vegetativas





Controle da erosão – práticas vegetativas

Controle da erosão – práticas vegetativas

Controle da erosão – práticas vegetativas

Meyer et al. 1999

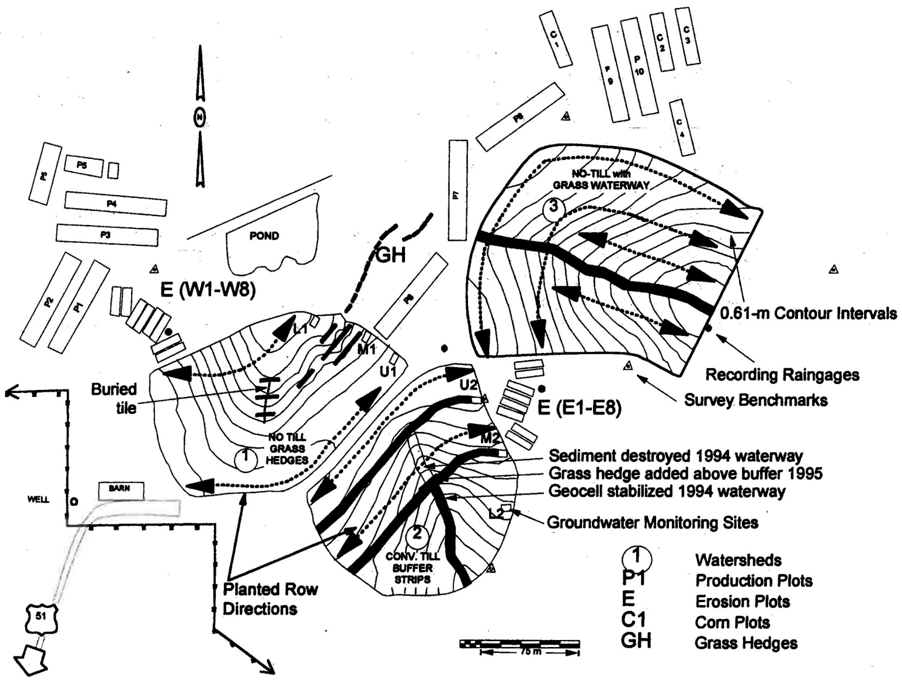


Figure 1–Layout of selected research plots and watersheds at the Nelson Farm, 1995.

Table 1. Crop management histories and soybean yields for three Nelson Farm research watersheds from 1988 through 1995

Year	Watershed No. 1 (2.13 ha)	Watershed No. 2 (2.09 ha)	Watershed No. 3 (3.17 ha)
1988	Tilled, 0.91-m row 1.92 t/ha	Tilled, 0.91-m row 1.86 t/ha	Tilled, 0.91-m row 1.71 t/ha
1989	Tilled, 0.91-m row 0.98 t/ha	Tilled, 0.91-m row 0.93 t/ha	Tilled, 0.91-m row 0.86 t/ha
1990	No-till, 0.91-m row 1.15 t/ha	Tilled, 0.91-m row 1.03 t/ha	No-till, 0.91-m row 0.83 t/ha Waterway seeded May & Oct
1991	No-till, 0.91-m row 2.02 t/ha	Tilled, 0.91-m row 1.79 t/ha Buffer strips seeded Oct	No-till, 0.91-m row 1.60 t/ha
1992	No-till, 0.91-m row 2.73 t/ha	Tilled, 0.91-m row 2.83 t/ha	No-till, 0.91-m row 3.03 t/ha
1993	No-till, 0.18-m drill 2.09 t/ha	Tilled, 0.91-m row 1.96 t/ha	No-till, 0.91-m row 1.81 t/ha
1994	No-till, 0.18-m drill 2.69 t/ha Grass hedges transplanted May	Tilled, 0.91-m row 2.14 t/ha Gully filled/waterway seeded Aug	No-till, 0.91-m row 2.51 t/ha
1995	No-till, 0.18-m drill 1.70 t/ha Gully filled/three hedges July	Tilled, 0.91-m row 1.55 t/ha Switchgrass added to buffer June	No-till, 0.91-m row 1.12 t/ha

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Erosion plots

Table 3. Average annual runoff and soil loss from erosion plots at the Nelson Farm

Cropping System	Plots	1990-1992 Rainfall Av. = 1540 mm Runoff (mm)	1990-1992 Erosion (t/ha)	1993-1995 Rainfall Av. = 1182 mm Runoff (mm)	1993-1995 Erosion (t/ha)	1990-1995 Rainfall Av. = 1361 mm Runoff (mm)	1990-1995 Erosion (t/ha)
Sb. conv.	W8 & E4	325 a*	9.00 a	185 a	12.66 a	256 a	10.84 a
Sb. nt. vol.	W7 & E5	233 abc	1.34 bc	171 a	1.16 b	202 a	1.25 b
Sb. wht. dbl.crop	W6 & E6	224 abc	0.58 c	148 a	1.25 b	186 a	0.92 b
Sb. ridg. till vol.	W5 & E3	222 abc	3.32 ab				
Cot. nt. vetch	”			178 a	3.96 ab		
Cot. nt. wht.	W1 & E2	305 ab	3.56 b	182 a	3.23 ab	243 a	3.38 b
Cot. nt. vol.	W2 & E1	193 bc	3.16 b	140 a	3.94 ab	167 a	3.56 b
Sorg. nt. vetch	W3 & E7	121 c	1.03 bc				
Corn nt. vetch	”			149 a	2.15 b		
Sorg. nt. vol.	W4 & E8	242 ab	1.70 bc				
Corn nt. vol.	”			162 a	2.20 b		

* Means within a column followed by the same letter are not statistically different ($P < 0.05$) based on the Satterthwaite approximation for the denominator degrees of freedom (SAS, 1996).

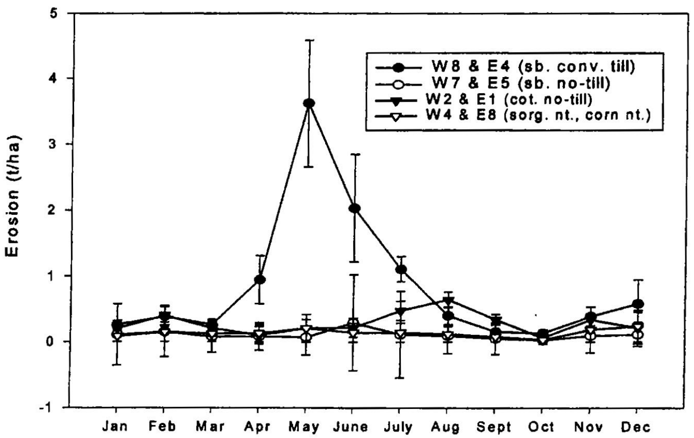

Figure 2–Average monthly erosion during six-year period (1990-1995) for several cropping systems on Nelson Farm erosion plots.

Watersheds

Table 6. Annual rainfall, runoff, and sediment yield from three research watersheds at Nelson Farm

Year	Rain (mm)	Watershed No. 1 Run-off (mm)	Watershed No. 1 Sed. Yield (t/ha)	Watershed No. 2 Run-off (mm)	Watershed No. 2 Sed. Yield (t/ha)	Watershed No. 3 Run-off (mm)	Watershed No. 3 Sed. Yield (t/ha)
1989	1570	594	18.6	690	44.0	824	28.7
1990	1730	540	1.2	691	10.2	750	2.2
1991	1730	632	0.5	870	32.6	805	0.7
1992	1157	240	0.3	284	19.0	300	0.4
1993	1150	237	0.4	300	2.9	332	0.2
1994	1340	331	0.9	437	77.3*	402	0.7
1995	1080	214	8.9†	364	6.4	305	0.3

Table 7. Average annual rainfall, runoff, sediment concentration, and sediment yield for three watersheds at the Nelson farm during one period when they received identical treatment and two subsequent periods when alternative farming practices were evaluated

Watershed and Gaging Period	Tillage Manage-ment System	Rain-fall (mm)	Run-off (mm)	Runoff (% of Rainfall)	Sediment Concen-tration (ppm)	Sediment Yield (t/ha)
Watershed No. 1						
1/89 to 4/90	Tilled	1671	577	35	1340	18.3
5/90 to 12/91	No-till	1760	653	37	81	0.4
1/92 to 12/95	No-till	1182	256	22	29*	0.5*
Watershed No. 2						
1/89 to 4/90	Tilled	1671	689	41	2520	40.4
5/90 to 12/91	Tilled	1760	888	50	5660	22.0
1/92 to 12/95	Tilled & buffer strips	1182	346	29	621*	12.3*
Watershed No. 3						
1/89 to 4/90	Tilled	1671	826	49	1490	28.2
5/90 to 12/91	No-till & grass waterway	1760	832	47	289	0.9
1/92 to 12/95	No-till & grass waterway	1182	335	28	28	0.4

* Excluding data from gully filling periods (see table 1 and table 6).

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Table 1. Treatment designations with their corresponding replications (Reps), tillage history, current tillage practice, and residue management.

Reps	History	Tillage	Residue	Designation
2	[a]Conv. tillage	Tilled	Residue left	Cth-tilled, RL
3	Conv. tillage	Tilled	Residue removed	Cth-tilled, RR0
2	Conv. tillage	Tilled	Residue removed	Cth-tilled, RR1
2	Conv. tillage	Not tilled	Residue removed	Cth-not tilled, RR0
1	Conv. tillage	Not tilled	Residue removed	Cth-not tilled, RR1
2	No-tillage	Not tilled	Residue left	Nth-not tilled, RL
5	No-tillage	Not tilled	Residue removed	Nth-not tilled, RR0
2	No-tillage	Not tilled	Residue removed	Nth-not tilled, RR1
3	No-tillage	Tilled	Residue removed	Nth-tilled, RR0
2	No-tillage	Tilled	Residue removed	Nth-tilled, RR1

[a] Conv. = conventional

Table 2. Treatment means for time to runoff initiation, maximum runoff rate, linear flow velocity, and maximum sediment concentration.[a]

		Runoff Initiation Time (min)			Maximum Runoff Rate (mm h^{-1})			Linear Flow Velocity (m h^{-1})			Maximum Sediment Conc. (mg L^{-1})		
Tillage	Residue	Dry	Wet	V. Wet	Dry	Wet	V. Wet	Dry	Wet	V. Wet	Dry	Wet	V. Wet
CTh-t	RL	12.0 a	0.9 cd	0.6b c	53.2 abc	55.2 b	49.9 c	180.6 a	238.3 a	399.6 ab	34650 cd	44050 cd	57800 bcd
CTh-t	RR0	8.1 abc	0.8 d	0.5 c	55.9 abc	60.6 ab	61.7 ab	248.9 a	341.5 a	337.5 ab	56500 bc	71000 bc	70400 bc
CTh-t	RR1	8.5 abc	0.8 d	0.5 c	57.0 abc	61.6 ab	63.6 ab	247.1 a	320.1 a	348.6 ab	67250 abc	83100 ab	90050 ab
CTh-nt	RR0	2.3 ac	1.1 cd	0.6 bc	60.5 ab	62.8 ab	63.4 ab	271.8 a	235.0 a	231.7 ab	36950 bcd	41100 d	44850 de
CTh-nt	RR1	2.5 bc	1.0 cd	0.6 bc	60.3 abc	65.4 ab	65.5 ab	293.2 a	430.6 a	457.9 a	50900 abcd	58200 bcd	66500 bcd
NTh-t	RR0	7.5 abc	1.3 bc	0.8 bc	51.8 bc	59.1 b	59.6 b	256.2 a	273.0 a	280.0 ab	22133 d	33300 d	38867 de
NTh-t	RR1	10.9 ab	0.9 cd	0.5 c	49.1 c	61.7 ab	63.2 ab	142.7 a	306.9 a	340.4 ab	94000 a	110950 a	101250 a
NTh-nt	RL	3.0 c	2.3 a	1.7 a	56.0 abc	58.3 ab	61.8 ab	193.2 a	162.0 a	131.8 b	8450 d	20750 d	13550 f
NTh-nt	RR0	3.5 c	1.7 b	1.0 b	59.1 ab	62.4 a	64.7 a	168.4 a	237.2 a	261.3 ab	16360 d	24380 d	23840 ef
NTh-nt	RR1	2.3 c	1.2 cd	0.6 c	63.4 a	62.5 ab	62.0 ab	197.1 a	263.5 a	287.1 ab	71150 ab	49750 cd	52050 cd

[a] Different letters indicate that treatments within a column are significantly different at the 0.05 level.

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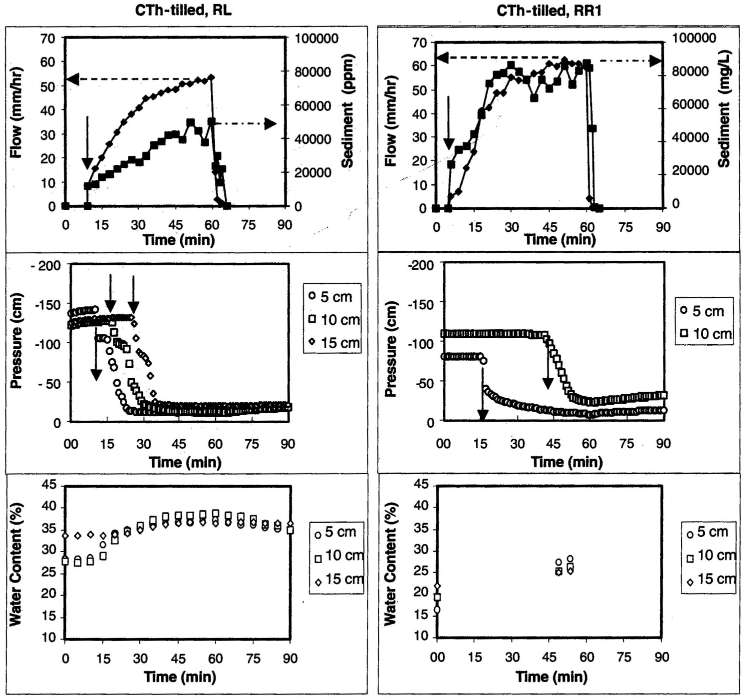


Figure 2. Runoff (flow), sediment concentration, soil water pressure, and soil water content by volume over time for the CTh-tilled for RL (left) and RR1 (right) treatments. Solid arrows indicate time to runoff initiation (upper graphs) and to tensiometer response (lower graphs); dashed lines indicate maximum runoff rates and maximum sediment concentrations.

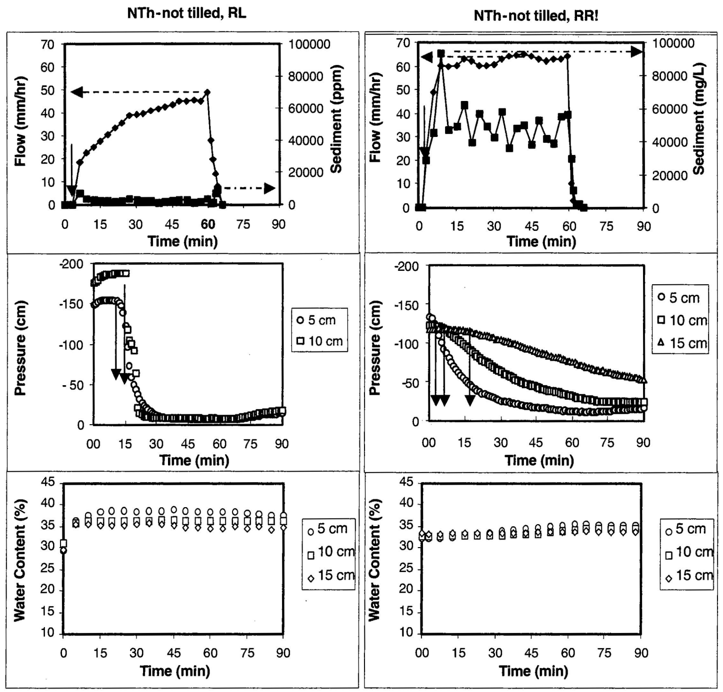


Figure 3. Runoff (flow), sediment concentration, soil water pressure, and soil water content by volume over time for the NTh-not tilled for RL (left) and RR1 (right) treatments. Solid arrows indicate time to runoff initiation (upper graphs) and tensiometer response (lower graphs); dashed lines indicate maximum runoff rates and maximum sediment concentrations.

Controle da erosão – práticas mecânicas

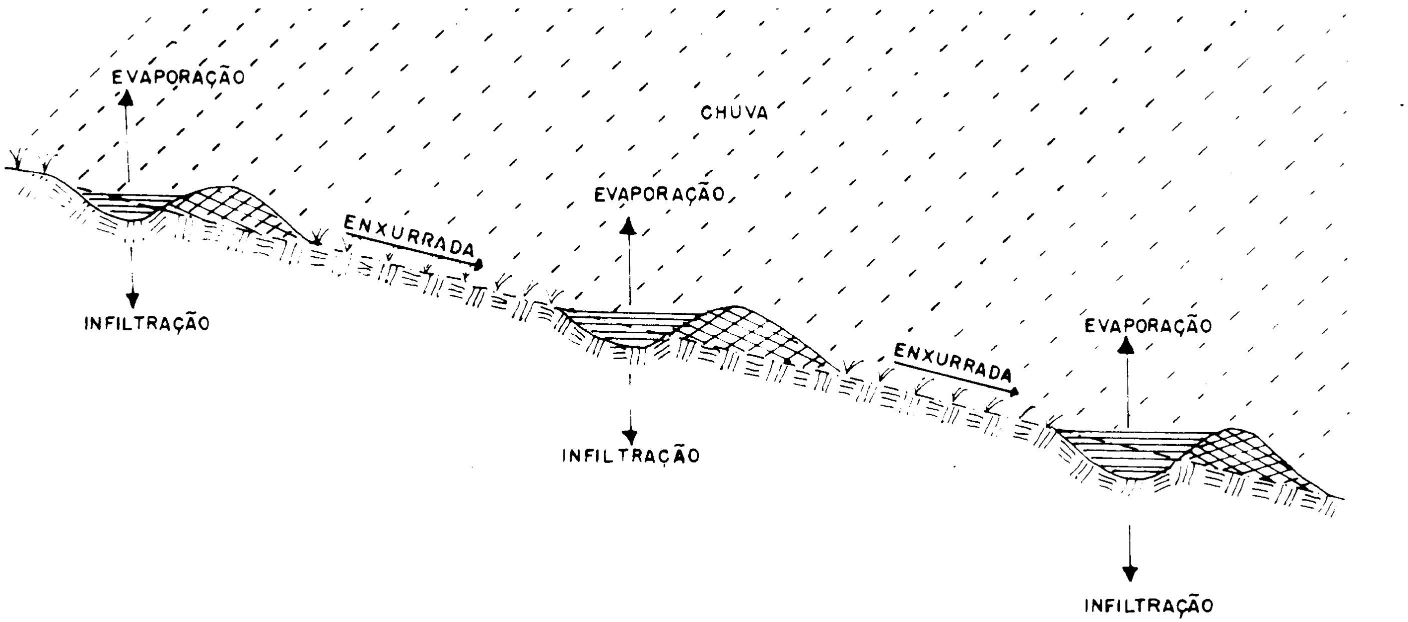
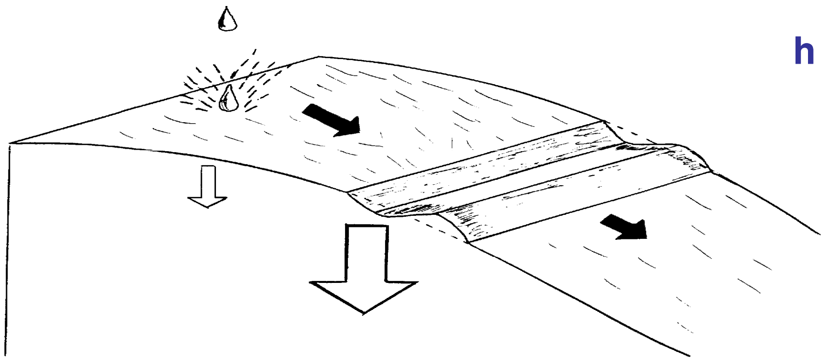
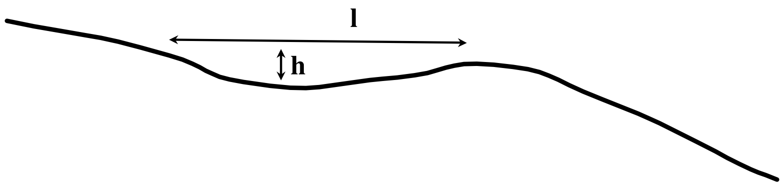


FIGURA 2 – Representação esquemática de um terraceamento mostrando a retenção das águas da enxurrada e o parcelamento do declive.

Controle da erosão – práticas mecânicas

Terraço de Infiltração





Para a avaliação dos terraços é preciso medir:

d = distância entre os terraços. (Ex.: 35m)
l = distância nivelada do camalhão até o nível do terreno. (Ex.: 6,0m)
h = altura do fundo do sulco do terraço até a crista do camalhão (Ex.: 0,8m)

$$\textit{Seção}\ (\mathrm{S,\ l/m}) = \frac{l \times h}{2} \times 1000$$

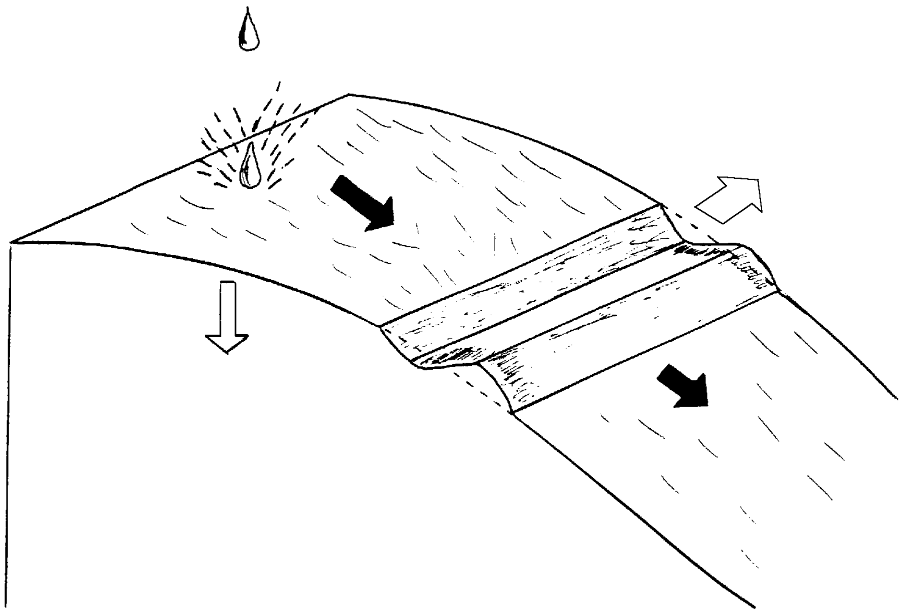
$$\textit{Seção}\ (\mathrm{S,\ l/m}) = \frac{6{,}0 \times 0{,}8}{2} \times 1000 = 2400\ \mathrm{l/m}$$

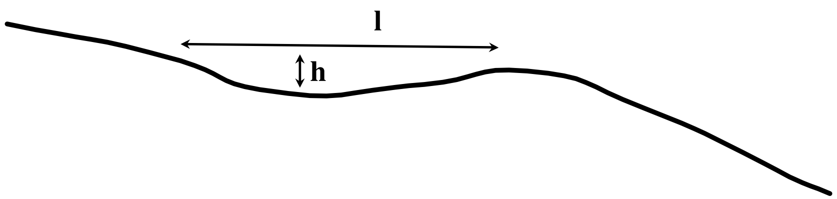
$$\mathrm{Chuva\ (mm)} = \frac{S}{d} \times 2$$

$$\mathrm{Chuva\ (mm)} = \frac{2400}{35} \times 2 = 136mm$$

Controle da erosão – práticas mecânicas

Terraço de Drenagem





Dimensionamento:

$$\text{Seção (S, l/m)} = \frac{l \times h}{2} \times 1000 \approx 1500 \text{ l/m}$$

Cálculo da declividade do canal:

-**Vazão**
-**Seção**
-**Eq. de Manning**
-Raio hidráulico

Controle da erosão – práticas mecânicas

Fórmulas básicas para dimensionamento hidrológico

$$P = \left\{ T^{\left(\alpha + \frac{\beta}{T^{0,25}}\right)} \right\} \times \{a \times t + b \times \log(1 + c \times t)\}$$

P = Precipitação máxima, mm
T = tempo de recorrência, anos
t = tempo de duração da chuva, h
α = constante que depende da duração precipitação (15'=0,122; 30'=0,138; 1h=0,156; 2h=0,166; 4h=0,174 e 24h=0,170)
ß = constante que depende da duração da e da localidade (5'= - 0,01; 15'= 0,09; 30'= 0,11 1h a 6 d= 0,11)
a, b, e ***c*** = constantes que dependem da localidade (a= 0,38; b= 26,73; c= 21,75)

$$Q_{max} = \frac{C \times i \times A}{360}$$

Qmax = vazão máxima esperada, m3 s-1
C = coeficiente de enxurrada.
i = intensidade (mm h-1) da precipitação máxima esperada com certo período de retorno (normalmente 15 anos) e de duração igual ao tempo de concentração.
A = área de captação no ponto de dimensionamento, ha

Controle da erosão – práticas mecânicas

Fórmulas básicas para dimensionamento hidrológico

$$V = \frac{1}{n} \times R^{\frac{2}{3}} \times \sqrt{i}$$

V = velocidade da água num canal aberto, m s-1 (varia de 0,5m s-1 a 1,5m s-1 em terraços e canais escoadouros)
n = coeficiente de rugosidade, varia de 0,06 a 0,1 em canais de terra vegetados
R = raio hidráulico do canal (área molhada / perímetro molhado)
i = declividade do canal, m/m

Velocidade de escoamento superficial (V, m s-1) em função do tipo de superfície e do declive (I, %).

Uso da terra	Velocidade, m s^{-1}
Florestas ou mata natural	$V=0{,}08\ I^{1/2}$
Área reflorestada ou em cultivo mínimo	$V=0{,}15\ I^{1/2}$
Pastagens	$V=0{,}21\ I^{1/2}$
Áreas cultivadas	$V=0{,}27\ I^{1/2}$
Solo descoberto	$V=0{,}30\ I^{1/2}$
Talvegues ou canais vegetados	$V=0{,}45\ I^{1/2}$
Áreas pavimentadas	$V=0{,}60\ I^{1/2}$