Relationship between size of vegetative buffers and transport of fecal coliform bacteria from pasturelands treated with dairy cow manure

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Keeping manure out of water

- Transport a complex function of many interrelated variables

1) Bacterial loading
2) Soil conditions (moisture, air space)
3) Rainfall rate and intensity
4) Microbial die off (time in-between applications)

-Castelle et al., 1994, Wenger, 1999, Gerba et al., 1975

Vegetative buffer strips

- Generally accepted as useful, but effective?
- Studies have not always agreed.

1) 100% removal with strips 6.1, 12.2 and 18.3 m with simulated rainfall of 7.4 cm. *Edwards et al., 1997*
2) Vegetative strips not adequate in meeting water quality goals (70% reduction in fecal coliform at 10 m) *Walker et al., 1990, Coyne et al., 1998*

Objectives

1) Examine FCB transport across vegetative filter strips of various sizes and slopes and compare to no buffer

2) Understand cost/benefit of increased buffer size or design

Materials and Methods

- Site had no manure for three years
- 22 experimental treatment cells (14 m x 30 m)
- Each cell had a simulated pasture area that was mowed periodically
- Designated vegetative buffer strip (0,1,5,8,15,25m)
- Designed to be hydrologically isolated by using ditches all around the cell

Materials and Methods

- Eleven cells were on a gentle slope (3.8%) and eleven were on a moderate slope (7%)
- Each cell had two samplers (1.2m) installed in the ditch running perpendicular to the cell
- Separated compartments connected to 10 sampling bottles
- Samplers were designed to catch overland flow and shallow groundwater (15cm) flow from the treatment cell

Materials and Methods

- Treatment/sampling was planned prior to and during major storm events
- Fresh scrape manure was applied (132.5 L) in a 10.8 m strip across each cell
- Water samples from each cell were collected at 24 hour intervals, pooled and analyzed for fecal coliform bacteria
- Nine storms were sampled over 2 years


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Materials and Methods

- Year 1
  - Two storms sampled
  - first storm no manure applied
- Year 2
  - Seven storms sampled

Precipitation

Storm	Precipitation (cm)	Precipitation Flux to each experimental cell per unit of pasture length (L/m)
1	13.4	1584
2	4.1	480
3	10.7	1269
4	4.5	537
5	3.3	387
6	9.6	1145
7	20.4	2407
8	6.7	788
9	8.1	954

Percent runoff by storm

	1	2	3	4	5	6	7	8	9
Gentle slope	.21	.1	.03	.12	.58	.08	.06	.09	.04
Mod. Slope	.12	.06	.03	.12	.28	.04	.04	.09	.03

Bacteria Concentration (gentle slope)

	Storm 1	Average cfu/100ml	Median cfu/100ml
Control	262	328	6
25m	2	4	1
15m	15	296	0
8m	6	48	10
3	0	303	34
1m	6	478	10
Zero	0	164,627	5,896

Bacteria Concentration (moderate)

	Storm 1	Average cfu/100ml	Median cfu/100ml
Control	0	3	1
25m	6	1,29	6
15m	116	522	2
8m	0	1	0
3	1	59	16
1m	7	8	6
Zero	9	2,008	786

Conclusion

- Only 10% of all treatment cells with buffers had FCB >200 cfu/100ml
- Any buffer greater than 1 meter reduced FCB by over 99% (average was $26x10^6$ cfu/100ml)
- No differences between cells on different slopes
- Soil type (infiltration capability) may be the most important variable in determining buffer size to effectively reduce FCB runoff