Potential Applicability of a Low Cost Drip Irrigation System for Sustainable Crop Production in Philippine Upland Watershed

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Seminar Presented at SEARCA
September 2, 2008

Drip Irrigation

- irrigation method involving delivery of water through a pipe distribution network consisting of a main pipe, submain, manifold and lateral pipes under low pressure and emission through small outlets of drippers or emitters into the soil surrounding the crop to be irrigated
- a.k.a trickle irrigation or microirrigation

Advantages of Drip Irrigation

- Adaptable to any crop, soil and topography
- Can be used under limited water supply conditions
- High water use efficiency
- Low operating costs
- Easier field operations
- Minimizes incidence of leaf diseases caused by direct water contact
- Facilitates liquid fertilizer application thru fertigation

Major Disadvantages of Drip Irrigation

- High cost (esp the conventional systems)
- Susceptibility to clogging

Types of Drip Irrigation
(~ on emitter types)

- Orifice type
- Pressure compensating
- Long path
- Tortuous path
- Vortex
- Flushing

The IDE Easy Drip Kit

- Developed by the International Development Enterprises (IDE)
- Makes use of microtubes for emitters
- Relatively inexpensive (<$500/ha or PhP 22,500/ha compared to $1,200 to $3,000/ha or PhP 54,000 to 135,000/ha for conventional drip systems, Smith (2008))
- Operates at relatively low pressure
- Adaptable to small areas (comes in packages for 20 sq.m., 100 sq.m., 200 sq. m. and 500 sq.m.areas)

The IDE Easy Drip Kit

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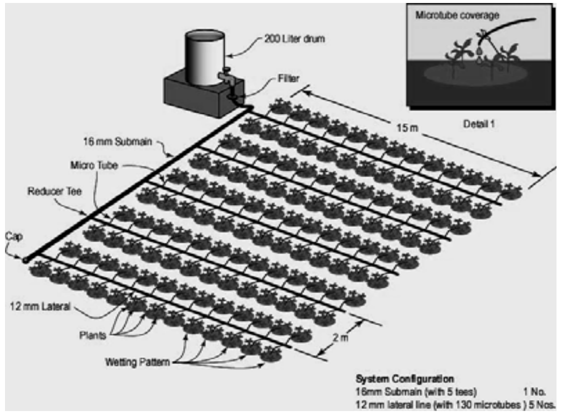

Source: Keller (2002)

Applicability of Easy Drip Kit in Upland Watersheds

Typical view of cultivated upland watershed (Lantapan, Bukidnon)

Source: M.R. Reyes et al., 2008 SANREM-CRSP

Issues on Drip Applicability in Upland Watersheds

Maximization of crop yield depends on irrigation water distribution uniformity
Uniformity of water distribution is affected by operating head and slope
The choice of operating head is compounded by topographic condition

Basic Question:

What operating head to employ to maximize water distribution uniformity under sloping conditions?

Laboratory Drip Experiments

OBJECTIVE

To determine the effect of hydraulic head and slope on the water distribution uniformity of the IDE 'Easy Drip Kit' and consequently develop mathematical relationships to characterize the effect of slope and head on water distribution uniformity

METHODOLOGY

100 sq. m IDE Easy drip kit (10 m x 10 m)
Submain Slopes: 0%, 10%, 20%, 30%, 40% and 50% (S_l = 0%)
Operating Head: 1.0 m, 2.0 m and 3.0 m
Sampled from 11 emitters per lateral for a total of 110 samples
Direct volumetric measurement for emitter discharge
3 trials per setting
At least 54 laboratory experiments

Experimental Set-up for Testing the IDE Drip Irrigation System

College of Engineering & Agro-industrial Technology, University of the Philippines Los Baños

Source: Ella et al. (2008)

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Sampling and Data Collection

Evaluation of Water Distribution Uniformity

Christiansen's Coefficient of Uniformity

$$CU = 100\left(1.0 - \frac{\sum_{i=1}^{n} |q - M|_i}{\sum_{i=1}^{n} q_i}\right)$$

where:
UC = coefficient of uniformity (%)
q = emitter discharge
M = average of discharge values

Evaluation of Water Distribution Uniformity

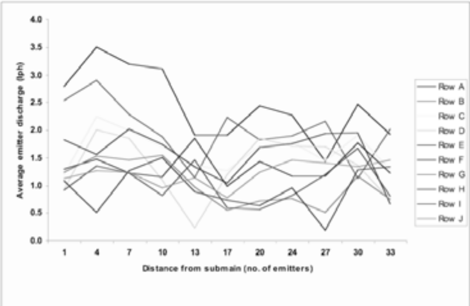
Merriam and Keller's Emission Uniformity

$EU = (q_{LQ}/q_{mean})100$

where:
EU = emission uniformity (%)
q_{LQ} = average of the lowest quarter of the observed discharge values
q_{mean} = average of observed discharge values

RESULTS

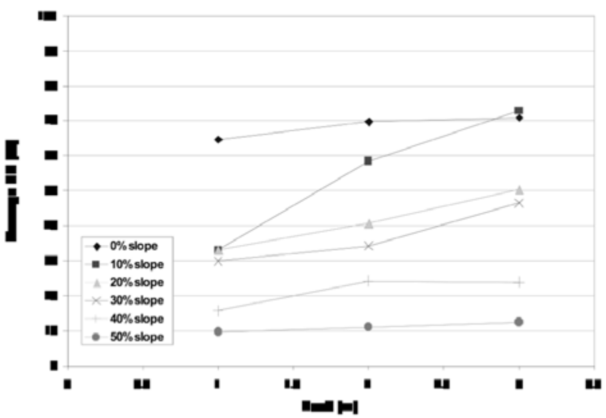
Typical emitter discharge variation along the lateral of the IDE drip kit at 0% slope



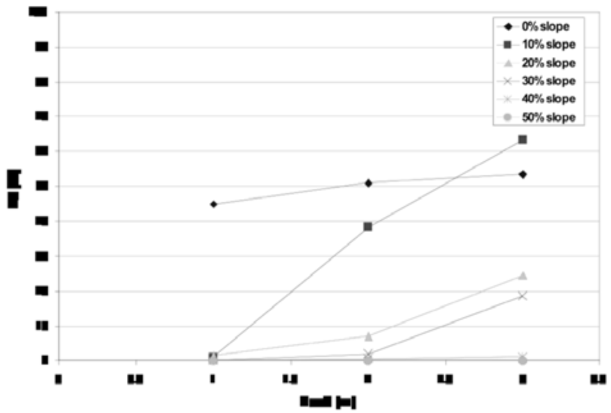
UC and EU at various Heads at 0% slope

Head (m)	Coefficient of Uniformity, UC (%) 1	2	3	Mean	Emission Uniformity, EU (%) 1	2	3	Mean
1.0	66.99	62.51	64.82	64.77	52.10	38.89	43.98	44.99
1.5	70.66	68.68	70.10	69.81	50.79	50.33	50.01	50.38
2.0	72.62	66.81	70.15	69.86	56.13	46.89	49.81	50.95
2.5	65.24	62.87	65.67	64.60	46.81	38.06	46.47	43.78
3.0	72.48	70.47	70.06	71.00	55.11	53.61	51.80	53.51
3.5	72.20	67.56	71.37	70.38	53.24	45.52	51.35	50.04

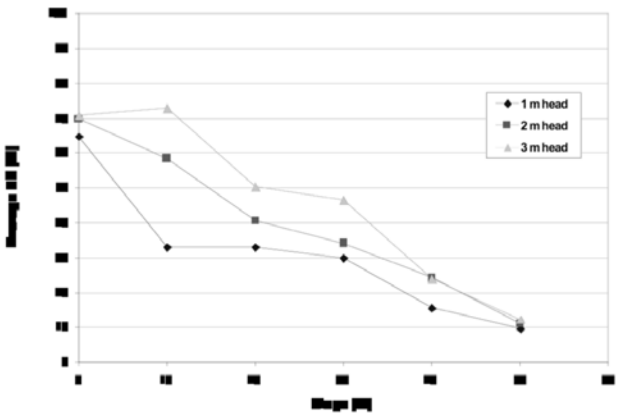
Effect of Head on UC at Various Slopes



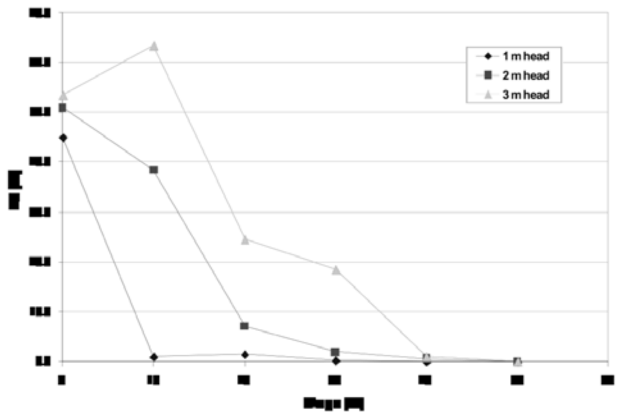
Effect of Head on EU at Various Slopes



Effect of Slope on UC at Various Heads



Effect of Slope on EU at Various Heads



Linear Regression Models for UC as a Function of Head at Various Slopes

Slope (%)	Linear Regression Model*	R^2
0	Y=1.50X + 65.02	0.233
10	Y=19.90X + 15.06	0.975
20	Y= 8.67X + 24.09	0.995
30	Y = 8.32X + 20.25	0.927
40	Y=4.14X + 12.98	0.722
50	Y = 1.35X + 8.37	0.997

* Y = coefficient of uniformity, UC (%)
  X = head (m)

Linear Regression Models for UC as a Function of Slope at Various Heads

Head (m)	Linear Regression Model*	R^2
1.0	Y= -0.95X + 54.69	0.850
2.0	Y= -1.15X + 68.57	0.987
3.0	Y= -1.27X + 77.91	0.943

* Y = coefficient of uniformity, UC (%)
  X = submain slope (%)

Summary of Findings from Lab Experiments

Water distribution uniformity of the 100 sq m IDE Easy drip kit proved to be influenced by operating head and submain slope

UC and EU increase with increasing head for all slopes

A head of 3.0 m may be considered as optimum from both hydraulic and practical considerations for all slopes

UC and EU decrease with increasing slope for all heads

UC and EU decrease tremendously for slopes > 30%

Findings (cont'd.)

For 0% slope, a head differential of 0.5 m does not cause significant change in UC or EU

UC is linearly related to either head or slope

Linear regression models proved to be adequate to characterize the relationship between UC and head and between UC and slope

Field Experiments

Initial Findings from Field Experiments

Crop	With Drip	Without drip
Cabbage	4.5 kg/sq m	2.4 kg/sq m
Chinese cabbage	6.0 kg/sq m	3.3 kg/sq m

Initial Findings from Field Experiments

Higher crop yield under drip irrigated crops than rainfed crops (with all other production inputs the same for both treatments)

Relatively larger size of produce under drip irrigated over rainfed

Higher plant height under drip than under rainfed

Social Considerations
(Farmer trainability issues)

SANREM Training on Drip Irrigation, Lantapan, Bukidnon, May 2007

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SANREM Farmers Field Day, Lantapan, Bukidnon, September 2007

CONCLUSION

- The IDE low-cost drip kit is highly adaptable to vegetable and high value crop production systems in Philippine upland watersheds
- The IDE low-cost drip kit has a great potential for adoption in Philippine upland watersheds for sustainable vegetable production based on technical and social considerations
- The low-cost drip irrigation system can potentially maximize crop yield and farmer's income and alleviate poverty

RECOMMENDATION

IDE may consider including affordable pressure regulators for use of the drip kit in steep slopes to minimize non-uniformity of water distribution
Emitter clogging should be addressed to prevent occurrence of minimal or zero emitter discharge
Government should consider pouring resources on drip irrigation technology adoption in the Philippines as part of poverty alleviation program for upland farmers

Acknowledgements

This project is part of SANREM-CRSP funded by USAID through Virginia Tech, North Carolina A&T State University and University of the Philippines Los Baños Foundation, Inc.
International Development Enterprises
Dr. Jack Keller of Utah State U and IDE
Engrs. Arthur Fajardo and Noel Gordolan, Nelsa Olilla and everyone who helped in data gathering

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