

# Letter to the Editor

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## **Comment on: Paper "Water Harvesting and Marketing (WHAM) for Dryland Cropping with 7–20 Inches (17.5–50 cm.) Annual Rainfall" by H.D. Fuehring in *Applied Agricultural Research* 2(2):107–112, 1987**

Runoff farming is a water supply technique that is potentially useful in many areas where precipitation is marginal for crop production. Water is collected from a portion of the land (catchment or runoff area) and diverted to the crop growing area (runon area). Fuehring's article presented an economic evaluation of a system utilizing a sodium salt treatment on the catchment area to increase precipitation runoff for growing grain sorghum. In the analysis the author assumed a runoff efficiency of 100% from the catchment area. This is considerably higher than has been reported by other researchers and an important component of the analysis. Adjustment for more realistic runoff values increases the unit cost of the runoff water from Fuehring's \$2.97/A-in. (\$2.89/ha-cm) to over \$7.70/A-in. and may change the economic benefits. Fuehring's article does offer an approach to estimating the potential benefits of runoff farming when the proper parameters are used.

Fuehring's article presents a concept for increasing crop production in areas where precipitation is marginal for normal agronomic practices and has high potential benefits for many parts of the world. The procedure is a modification of runoff-farming/water-harvesting systems used over 4,000 years ago by farmers in the Middle East (Myers, 1975). These early techniques used "natural" materials, such as soil crusts and rock surfaces for precipitation collection areas (runoff or catchment area, designated as shed area by Fuehring). The collected water was directed to lower crop growing areas (runon areas). In the past 20 years, techniques have been developed for mixing sodium chloride salts into the soil of the catchment surface to reduce water infiltration and increase the quantity of runoff (Hillel, 1967; Evett and Dutt, 1985a; Evett and Dutt, 1985b; Fuehring, 1986; Frasier et al., 1987). Fuehring's article was based on diverting the water collected from a sodium salt treated area

onto a crop growing area for producing grain sorghum.

Fuehring advocates salt application rates of 1 ton of salt per A (2240 kg/ha) for treating the catchment area and indicates in Table 1 that the runoff is 100% of the growing season precipitation. The assumption of 100% runoff is of significant importance in the analysis. Frasier et al. (1979) reported runoff efficiencies of 74 to 100% from membrane water harvesting treatments. It would be expected that runoff from soil modifying treatments such as sodium dispersion would be less than from the membrane covered surfaces. Evett and Dutt (1985b) reported 55 to 69% runoff efficiencies from 9 to 18 ft (3–6 m) long catchments with 1 to 15% slope on a Whitehouse loam (Fine, mixed, thermic Ustollic Haplargid) soil with 46% sand, 33% silt, and 21% clay treated with 5 tons/A of sodium chloride. Fink and Ehrler (1986) reported annual runoff efficiencies of 39 to 57% for a 4-year study period from a Glendale silty loam (mixed calcareous, thermic Typic Torrifluent) with 11% sand, 76% silt and 13% clay treated with sodium chloride at 5 tons/A.

The texture and chemistry of the soil can affect the effectiveness of the sodium salt treatment for sealing the soil and increasing precipitation runoff (Kemper and Noonan, 1970). Fuehring's studies were conducted on a Pullman silty clay loam (fine, mixed, thermic Torrertic Paleustoll) (Fuehring, 1986). This soil will have a higher clay content than the previously referenced studies but without some measured runoff data it is difficult to predict the actual quantity of runoff that may occur. Based on the studies of Evett and Dutt (1985a) and Fink and Ehrler (1986), precipitation runoff efficiencies from soils treated with sodium salts at 1 ton/A are probably less than the 100% used in Fuehring's analysis.

If there is less than 100% runoff, it is necessary to increase the size of the runoff area in direct proportion to the expected reduction in runoff efficiency. Otherwise the crop will be receiving less water than needed.

The \$12/A (\$29.50/ha) valued used by Fuehring for the cost of shipping and application of the salt is lower than was quoted for a study in the Phoenix, AZ area in 1984. The paper states that the salt is applied, then there are two passes with a rotary hoe to mix the salt in the soil, and finally the soil is packed with tractor wheels. This represents a min-

imum of four operations or passes with equipment. Estimated costs for each of these operations is \$8–10/A per pass. (Personal communications with the Pima County Extension Agent).

Using these assumptions and the author's approach in calculating the cost of the treatment, the cost of the collected water at Clovis, New Mexico would be:

Cropland \$250/A*	
Annual cost at 12% rent	\$30.00/A
Cost of landscaping (single pass)	\$10.00/A
Salt @ 1 ton/A @ \$13/ton (at mine)	13.00
Application of salt	
No shipment costs to site	
(4 passes @ \$8/A pass)	<u>32.00</u>
Total treatment cost	\$55.00/A
Treatment depreciation over 10 years	\$ 5.50/A
Interest @ 12% of \$27.50	<u>3.30/A</u>
Total annual treatment cost	\$38.80/A

The author states that there are normally 2 in. (5 cm) of runoff from the 12.0 in. of growing season precipitation leaving 10 in. for potential collection. Based on the results from a loam soil (Evet and Dutt, 1985a) and a silty loam soil (Fink and Ehrler, 1986), the 1 ton/A salt treatment might be expected to yield 50% runoff or collect 5 inches of the available precipitation. The cost of the additional collected water is then:

$$\$38.80/5 = \$7.76/A \text{ in. } (\$7.55/ha \text{ cm}).$$

This is over two times the value of the water that Fuehring used in the economic analysis. This illustrates the importance of selecting the proper rates of runoff. Whether the collected water is of economic benefit is dependent upon the particular crop and its yield response to the additional water. From a risk analysis approach, it may be better to use a lower runoff efficiency. Also, economic analysis at other sites would have to reflect the local costs of land, salt, and landscaping-application operations.

Another factor that needs to be considered is the potential soil erosion from the treated catchment areas. The salt disperses clay aggregates. The dispersed clay is susceptible to water erosion unless the catchment slopes and lengths of overland flow are carefully designed and controlled (Hillel, 1967). The shape of the author's catchments are 6 in. high and 48 in. long, (12.5% slopes). Evett and Dutt (1985a) reported soil losses of 2.7 tons/A from

catchments of 9 ft (3 m) and 10% slope. This erosion rate is not considered excessive but Evett and Dutt recommended keeping catchment slopes less than 5%. It is possible under some soil-topography conditions that the dispersed clay can be washed into the crop growing area which could reduce the rate of water infiltration. As Fuehring notes, each system must be carefully designed to stay within tolerable soil erosion limits.

Finally, irrespective of the economic benefits, the practice must be acceptable to the farmers that are expected to adopt the technology. The proposed system may require that the farmer change some of the "normal" farming practices and stay off the salt treated areas. Any mechanical damage to the runoff area will necessitate added costs in maintenance of the runoff area.

Runoff farming was a viable practice in the past and can be a useful alternative for the future. There is a considerable amount of knowledge available but much of it is in "bits and pieces." At the present time there is no "best" technique that is applicable to all situations. Success will come by application of the proper technology at the proper place. The users must decide what is the proper technology for their applications and soils.

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\* Multiply costs per acre by 2.47 to obtain costs per hectare.

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## Reply to Frasier

Regarding the proportion of runoff estimated, 12 in. out of 16.5 in. annual rainfall or 73%, the long term study at Clovis resulted in yields closely in line with the variable rainfall. This assumes that runoff during the off-season compensates for any discrepancy during the growing season. The percent runoff depends on both the shedding surface of the soil as well as the rainfall pattern. The summer rainfall at Clovis tends to be mostly from high intensity thundershowers resulting in greater runoff than in areas where much of the rainfall occurs as light showers subject to considerable evaporation. Also, the relatively high clay content of the soil probably results in better sealing of the surface. The clay here does not result in excessive soil cracking as it dries out. In view of the yields obtained, I believe the runoff figures are reasonable.

Regarding the cost of land shaping, most farmers have to beat the cited \$8 to \$10/A per pass considerably or they won't be in business long. For example, I can hire custom one-waying done for \$4/A and the man is making money. Also, the four passes we used in putting in our first sheds are probably more than necessary. One very shallow disking or one-waying will suffice for salt incorporation. Also, the first rain will take the place of a mechanical packing operation.

The figures given in the article were meant to be illustrative and serve as a basis for discussion. It is expected that each situation will require recalculation according to local conditions.

It is concluded that the estimations in the original article were a reasonably close fit.

Regarding the concerns about erosivity of the shed areas, our original slopes were about 6 in. in 60 or 10%. We found that the ridges tended to slump down over the years resulting in a probable final slope of less than 5%. The length of slope of about 5 ft did not result in rilling or visible erosion. Here again the local conditions would have to be considered.

Regarding travel on the ridges, travel should be restricted to dry periods only. Very large and heavy equipment might need to be avoided on some soils. Travel on the ridges would be much less harmful than the packing resulting from travel on the growing beds.

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