USING IRRIGATION TO INCREASE CROP PRODUCTION

Historically, irrigation has been an important agricultural technology with strong impact on crop productivity. On average, irrigated crop yields tend to be highter than those from unirrigated land (Lascano and Sojka, 2007), but there can also be unintended negative consequences of irrigation if it is not managed well including river and groundwater depletion and salinization.

Irrigation is useful in regions where the process of evaporation (E) and traspiration (T) (water loss from crop plants) exceed precipitation or rainfall.

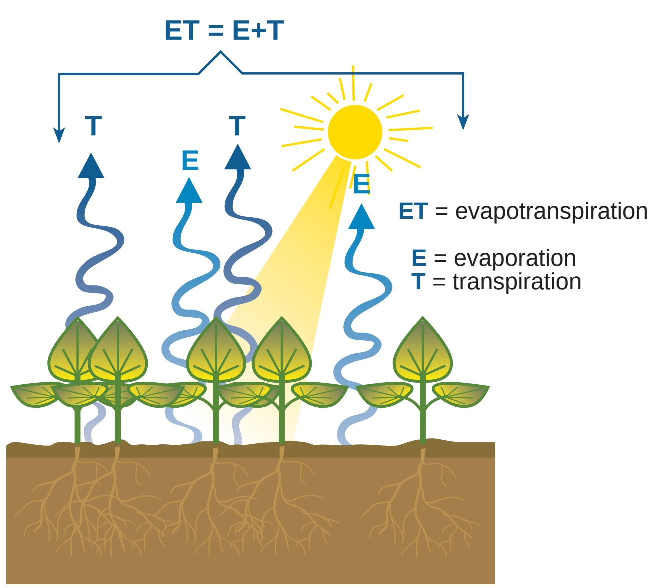
Factors that affect ET include:

- climate: windspeed, temperature, humidtiy
- field aspect or solar exposure
- crop type
- stage of crop growth
- soil moisture
- soil cover

ET estimations and deciding when to irrigate

A farmer can use a number of means for estimating ET and for scheduling irrigations:

- direct inspection or with a hand-push soil probe
- determine the available water holding capacity and the allowable water depletion for your soil type and the crop you're growing using the "feel method"
- setup a water pan in the sun with the allowable soil water depletion marked below the initial water level, and irrigate when the water evaporates to the marked level, and
- access local weather and ET data from the internet



The effective root zone

The top half of the actual root zone usually supplies about 70% of the crop's water needs.

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IRRIGATION SCHEDULING

How will you know when to irrigate and how much water to apply?

Monitoring moisture availability

- Crop stage of growth and vigor
- Air temperature and wind speed
- Rainfall or irrigation water applied
- Soil moisture

Calculations

- Daily crop water use or evapotranspiration
- Soil water balances and water available to plants

Wetting pattern of drip tape

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ADDITIONAL POSSIBLE BENEFITS OF COVER CROPS WHEN USED AS SURFACE MULCHES

When cover crops are converted to surface mulches, or when crop residues are maintained on the soil, they may serve to reduce soil water evaporation and thereby conserve water for crop transpiration. Thus, by generating and maintaining residues, a farmer, tries to “take the ‘E’ out of ‘ET’, to increase crop water use efficiency.

Estimates of water savings due to reduced tillage and surface residues have been determined to be upwards of 10 cm during a crop season in the US.

Onions growing in crop residue
Brazil, 2005

Tomatoes growing in cover crop residue
California, USA, 2008

Beans growing in crop residues
Nebraska, USA, 2007

Measuring soil water evaporation under residues and bare soil
California, USA, 2009

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USING COVER CROPS TO INCREASE CROP PRODUCTIVITY

What are cover crops?

Cover crops are legumes, cereals, or an appropriate mixture grown specifically to protect the soil against erosion; ameliorate soil structure; enhance soil fertility; and suppress pests, invading weeds, insects, and pathogens. When cover crops are converted to a surface residue mulch, they can also serve to conserve soil water.

Because low soil fertility has been a major constraint hampering the productivity of Kenyan small holder farms, and because legumes can play a major role in improving farm productivity, the Legume Research Network Project (LRNP) has done a lot of work in Kenya over the past 15 years to introduce legume cover crops throughout the country.

How much Nitrogen can cover crops provide?

Vigorous cover crops can be produced by following existing recommendations for species and variety selection,planting date, seeding rate, inoculation procedures and termination date. The amount of nitrogen a cover crop produces depends entirely on the cultural practices that are used.

kg N/ha	production strategy
0 - 112	as easy as falling off a chair
112 - 224	follow existing recommendations
224 - 336	skill, time, favorable weather, and lots of seed
> 336	multiple top removal over extended time periods

Findings of the Legume Research Network Project in Kenya 1995 - 1997

- greater crop yields with cover crop incorporation at most sites
- in semi-arid regions, mulching resulted in superior maize yields due to moisture conservation,
- returns to labor were higher with incorporation than mulching

Estimating cover crop N content

- harvest 1 m^2 of your cover corp
- weigh the fresh weight
- multiply the fresh weight times the conversion factor to get kg/ha

cover crop	conversion factor (kg/ha)
clover (Trifolium)	48
bell bean (Vicia faba)	37
cowpea (Vigna unguiculata)	44
vetch (Vicia dasycarpa)	59
grass (average)	23
legumes (average)	40

(http://uric.ucdavis.edu/veginfo/topics/fertilier/fertguide.html)

Typical Nitrogen needs of vegetable crops

vegetable	(kg/ha)
carrot	90 - 165
corn	135 - 270
melon	110 - 165
onion	135 - 335
potato	165 - 335
squash	90 - 165
tomato	110 - 225

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WHAT ELSE MIGHT BE DONE TO IMPROVE CROP PRODUCTIVITY?

- Consider organizing an "information collective" to share information
- Keep an "institutional memory"
- Connect with other regional and national agriculture information groups such as KARI and the Legume Research Network Program
- Set goals and seek help with other technology tools

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EVOLUTION OF AGRICULTURAL TECHNOLOGIES WITH STRONG IMPACT ON AGRONOMIC PRODUCTIVITY AND POPULATION CARRYING CAPACITY

Era	Locale	Technology
11000 - 9000 BC	Mesopotamia	Beginning of settled agriculture
9500 - 8800 BC	Sumerians	Use of supplemental irrigation
5000 - 4000 BC	Mesopotamia	Use of simple tools such as an “ard” or plow
3000 - 2000 BC	Indus Valley	Use of animal-driven plow
2500 - 2000 BC	Mespotamia	The concept of fertility of cropland soils
900 - 700 BC	Greece	Use of animal manure
370 - 280 BC	Rome	Use of green manures
1 AD	Rome	Use of lime and saltpeter (KNO3)
1604 - 1668 AD	Germany	Impact of saltpeter on plant growth
1100 - 1200 AD	Moorish Spain	Soil quality
1803 - 1873 AD	Germany	Use of chemical fertilizers
1950 - 1970 AD	U.S. corn Belt	Conservation tillage, no-till farming
1960s AD	Israel	Drip irrigation, fertigation
1980s AD		Biotechnology and GM crops
2000 AD		Deliver nutrients and water directly to plant roots, biomass-based H2 fuels, conservation tillage, land-saving technologies, precision farming, soil carbon sequestration

Lal et al., 2007. Soil and Tillage Research 93(2007): 1-12.

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