MAKE EVERY DROP OF RAINWATER COUNT

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PART 1

More rainwater into the ground = more and better-quality fodder produced

Drought is a recurring phenomenon in South Africa. Low rainfall is the main driver behind droughts. The inconvenient truth is that although the amount of rainfall is important, the effectiveness of that rainfall also plays an important role. Farmers have no control over the amount of rainfall they receive, but they do have control over its effectivity.

One needs to have a basic understanding of the water cycle to understand the concept of rainfall effectiveness.

Let us start with the precipitation part in the water cycle. It is the result of the condensation of the atmospheric water vapour into water that falls to earth under gravity from clouds. The main forms of precipitation include rain, drizzle, sleet, snow, ice pellets, graupel, and hail. Precipitation can have two fates, i.e. it can be so light that it evaporates again before it reaches the ground, or it can reach mother earth.

The precipitation that falls on the ground can either infiltrate into the soil, or run away into the rivers and streams (called runoff). The water that runs off is a loss

to the livestock farmer, as this precipitation does not contribute to the veld production, although measured in the rain gauge.

The water that infiltrates into the soil can either percolate deeper into the sub-soil and replenish the groundwater, or it can evaporate directly from the bare soil surface back into the atmosphere, or it can be absorbed by plants and transpired back into the atmosphere. The water that evaporates from the soil surface is lost to the livestock farmer as it was not absorbed by plants and thus did not contribute to veld production. The water that is transpired via the plant into the atmosphere is the only portion of the precipitation that contributes to plant production and is thus regarded as the effective portion of the rain received.

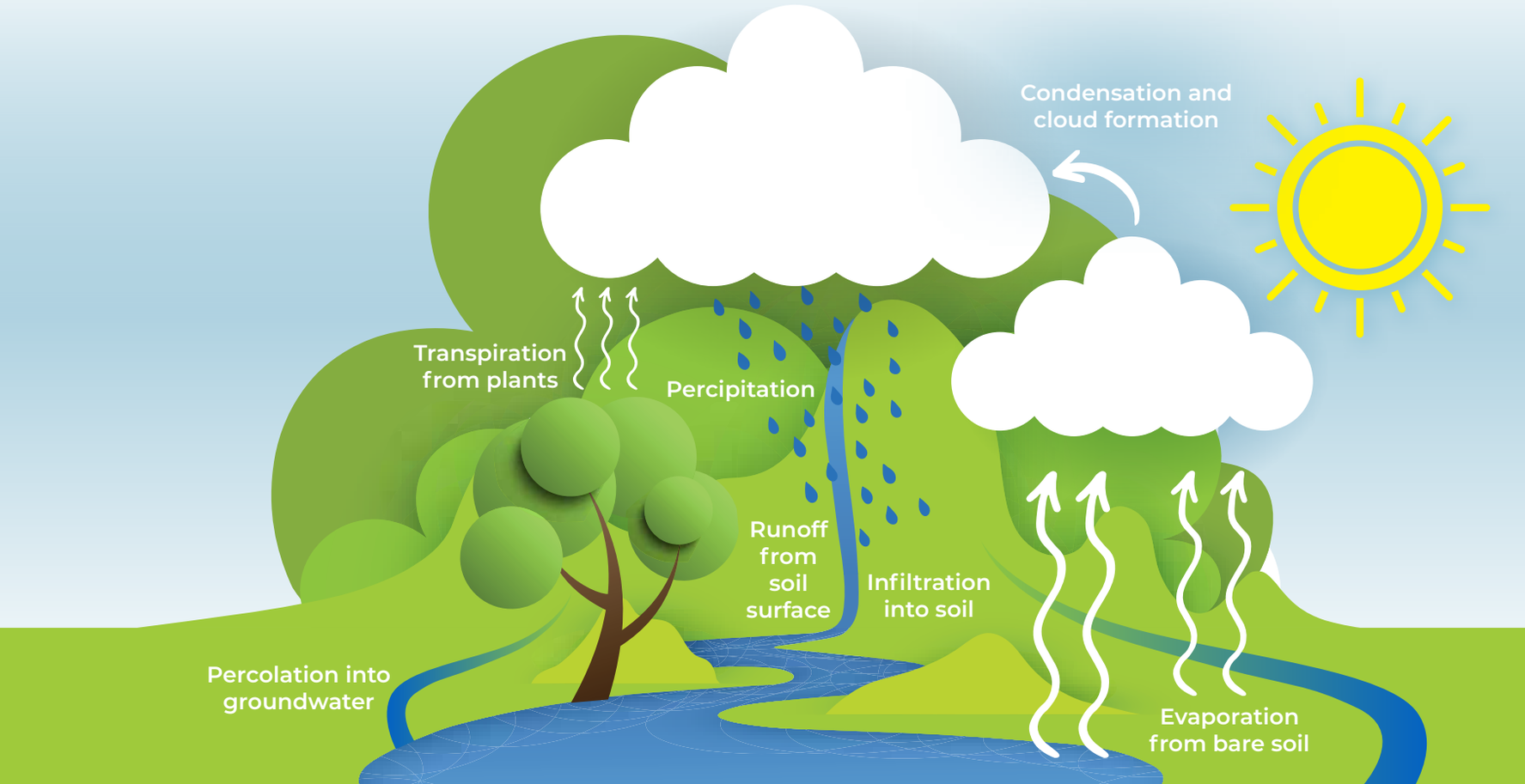
Finally, water evaporates either from open water sources (i.e. the sea or dams) or is transpired via the plants or evaporates directly from the bare soil into the atmosphere, then condenses to form clouds, which then again produces precipitation, to complete the water cycle.

This model provides a very basic explanation of the water cycle and which makes it clear that only that portion of the rainfall (precipitation) that infiltrates into the soil and is then transpired by the grazing plants contribute to the effective rainfall. That is the only portion of the water cycle that leads to forage production. The rest is lost for forage production, either through runoff, deep percolation into the underground water, or evaporation directly from the soil surface.

How does the water cycle apply to practical veld productivity?

Prof. Hennie Snyman (emeritus) has conducted ground-breaking research in the central Free State by studying the hydrology of the veld and the effect of the veld condition on rainfall effectivity.

Water that runs off is the first point of water loss for the livestock farmer. Snyman's research in the central Free State has shown that on average 9% of the rainfall received by veld in a poor condition runs away and is lost for veld production, while only 6% and 3% of the rainwater that falls on veld in an average and good condition respectively runs away. The loss of rainwater through runoff is thus three times as much from poor condition



veld as from veld in a good condition. The topography of the central Free State is relatively flat and it is expected that runoff would be much higher as the slope of the terrain increases.

Why does veld condition play such an important role in the amount of rainwater that runs off?

Veld condition affects, amongst others, the following factors that play a role in the amount of rainwater that infiltrates into the ground, i.e. the density of the sward, the above-ground organic matter content, and the health of the soil. The better the veld condition, the denser the plant cover, and the higher the above-ground organic matter content. The denser the plant cover and the higher the quantity of organic matter on top of the soil, the slower the rate of water flow, which then provides more favourable conditions for the water to infiltrate into the soil, and decreasing runoff. Recent research has also demonstrated the importance of soil health itself when it comes to the rate rainwater infiltrates into the ground.

A multitude of microorganisms lives in the root zone of plants. They feed on components exuded by the plant roots. On its part, these microorganisms have, amongst others, the ability to bind free nitrogen from the air into a form that their companion plants then access and use for growth and production. It also constitutes a major component of the below-ground organic matter sink of the soil, which on its part, improves the rate at which water can infiltrate into the soil.

It is speculated that each plant species in the sward has its own mix of microorganisms in its root zone and that the greater the variety of species in the sward, the more healthy the microbe population of the soil and the soil itself is. Here veld condition again plays an important role, as the biodiversity of the plants in a sward increase with improved veld condition.

A video on YouTube demonstrates this very eloquently. The video shows the infiltration rates of two swords with much the same plant density but with different plant species compositions. The water infiltration is significantly faster in the case of the more biodiverse sward, as compared to the sward with just a few plant species. This video can be accessed at the following link on the internet, i.e.: https://www.youtube.com/watch?v=IqB4z7lGzsg. One can thus conclude from all of the above that the better the veld's condition, the more of the precious rainwater ends up in the soil.

On the left is a tuft of grass that has been grazed correctly with a much denser rhizosphere than the grass on the right which suffers from overgrazing and poor root development.

(Photo provided by Prof. Hennie Snyman)

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What happens to the water that infiltrates into the soil?

Some will be lost from the system due to evaporation directly from the soil's surface. The lower the plant density and the amount of soil covered with organic matter, the higher the percentage of the bare soil and the more water is evaporated directly from the soil's surface, and the less water is then available for transpiration via the plants. Both plant density and organic matter content are also influenced by veld condition. The better the condition of the veld, the better the plant and organic matter cover of the soil, and the less water is evaporated directly from the soil's surface. This leaves more water in the soil for transpiration during the process of photosynthesis.

The story does not end here, though. Snyman's research also showed that the species of plants that dominate in poor condition veld have a considerably lower water use efficiency when compared to the plant species that dominate in good condition veld. For example, the species that dominate in poor condition veld produce only 0.8kg DM/ha/mm of water it transpires, compared to good condition veld that produces 2.5 kg of DM/ha/mm of water it transpires - three times more effective utilisation of water by the plants growing in good condition veld.

One can only really grasp this difference when these figures are converted into forage production/ha. The long-term average forage production of poor veld in the central Free State is 368kg/ha/annum, while veld in a good condition produces on average 1238kg forage/ha/year – with the same amount of rainfall received in the rain gauge. This truly creates a double whammy as the veld condition deteriorates. Poor condition veld is not only drier, due to less rainwater infiltration, increased runoff, and increased evaporation directly from the soil surface. Plants that dominate poorer veld also produce less forage for each mm of water it uses for transpiration. This situation is particularly negative during below-average rainfall years.

The final nail in the coffin is the fact that veld in a poor condition has a much lower quality when measured in kilogram crude protein produced/ha/year. Snyman established that poor condition veld in the central Free State produced on average 32kg crude protein/ha/year versus 141 kg/ha/annum for good condition veld.

The take-home message is that the very first step in making every drop of rain count, is to maintain the veld's condition in as healthy a condition as is possible. This requires a well-planned and correctly executed grazing management system based on sound grazing and animal production principles.

The second and last article in this series deals with the restoration of the water cycle through radical veld improvement of veld that cannot be achieved through normal grazing practices. ■