KeSEBAE NEWS

Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers

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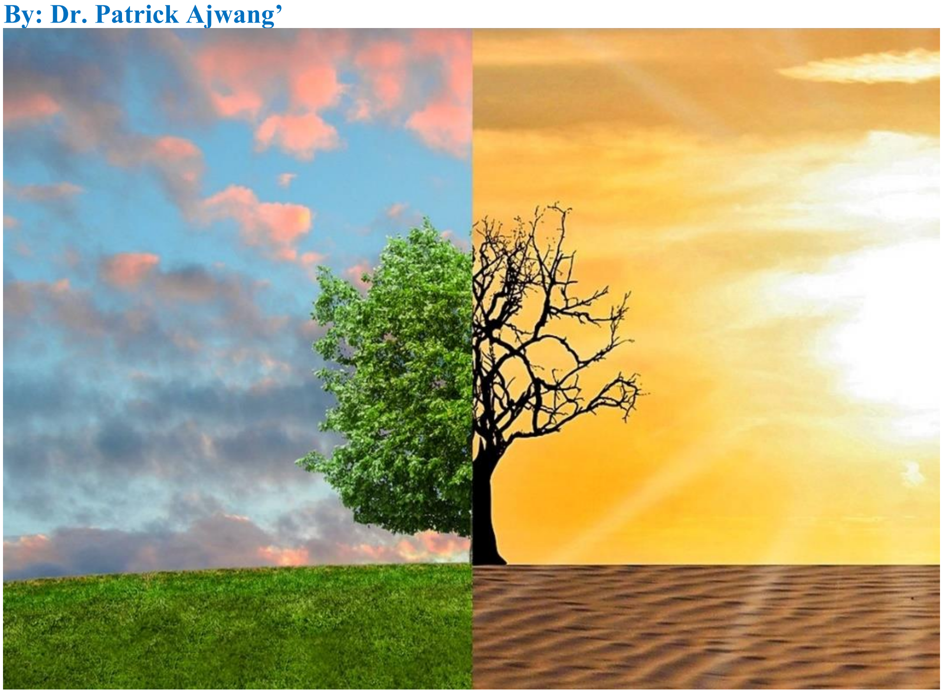
Understanding Evapotranspiration is Key to Lessening the Climate Change Angsts

By: Dr. Patrick Ajwang'



First year undergraduate students in agricultural engineering are normally introduced into the discipline through a core unit which deals with fundamental concepts in agriculture and agro-meteorology. One important concept that they have to understand before proceeding to higher levels is about how much water plants need to survive in varying climatic and soil conditions. Accordingly, two terms relating to water movement and loss in the growing environment are commonly discussed. These are infiltration and evapotranspiration, respectively.

Infiltration is a term used to describe the movement of water into the soil. Different types of soils have different rates of infiltration. For instance, sandy soils have faster infiltration rate than clay soils into which water movement is very slow.

DEAR READER

Welcome to KeSEBAE Newsletter.

A fortnightly Newsletter touching on topical issues affecting our environment.

KeSEBAE NEWS is a Newsletter of the Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE)

Inside this Issue!

Fig 1. Weather station, a key facility in Agricultural Engineering

Infiltration on its own is less important if not connected to the water holding capacity of a particular soil. The water holding capacity is the maximum amount of moisture that the soil can hold without causing runoff. Knowledge of infiltration and water holding capacity gives an idea on how much and how long to irrigate.

Fig 2. Fruit tree and vegetable irrigation based in evapotranspiration requirements

The water held in the soil is lost through evaporation, seepage, deep percolation and absorption by plant roots. The absorption by plant roots is made possible by the combination of osmotic pressure and capillarity caused by the evapotranspiration stream. Evapotranspiration in this case is the term applied to the loss of water by evaporation from the soil surface around the plant as well as the moisture movement from the leaves of the plants. The plants leaves have some free water on the surfaces as well as water which comes out through the stomatal openings. Evapotranspiration causes a suction force which enables the translocation of water and nutrients through the plant into the leaves.

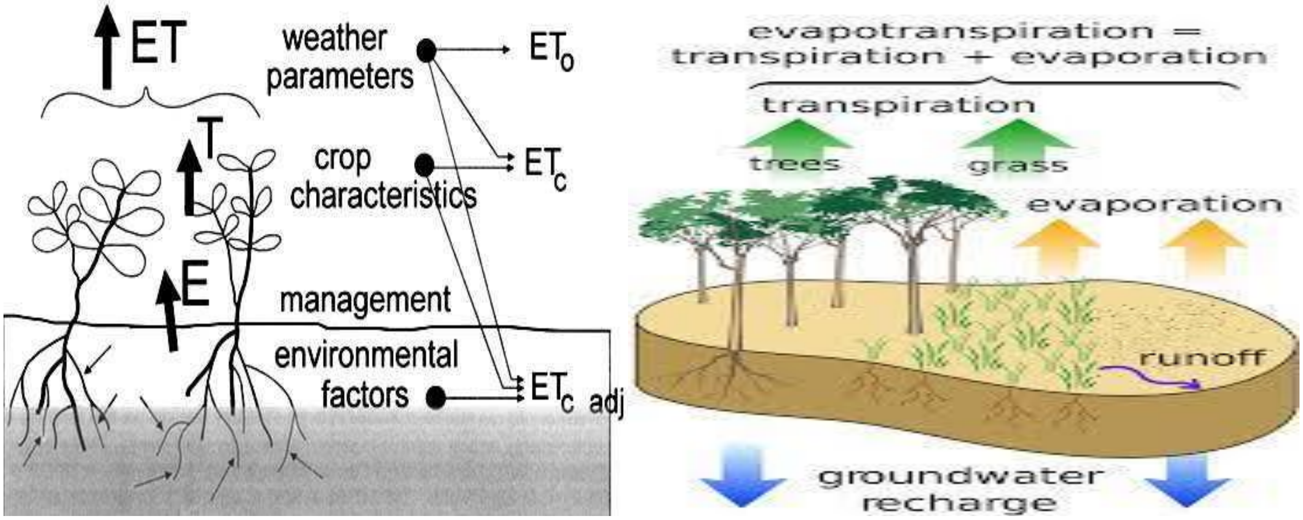


Fig 3. Evapotranspiration and translocation in plants

Only a small fraction of the water absorbed by the plants is used in photosynthesis and biomass formation. A larger fraction of the water is lost through the process of transpiration from the leaves. Transpiration has a cooling effect on the plant and helps modify the microclimate around the plant. This is possible because during the transpiration process sensible heat energy is converted in latent heat of evaporation enabling the conversion of moisture from the leaves into water vapour (gas). The latent heat of vaporization of water is relatively high, making transpiration and evaporation very effective in cooling the plants and their surroundings.

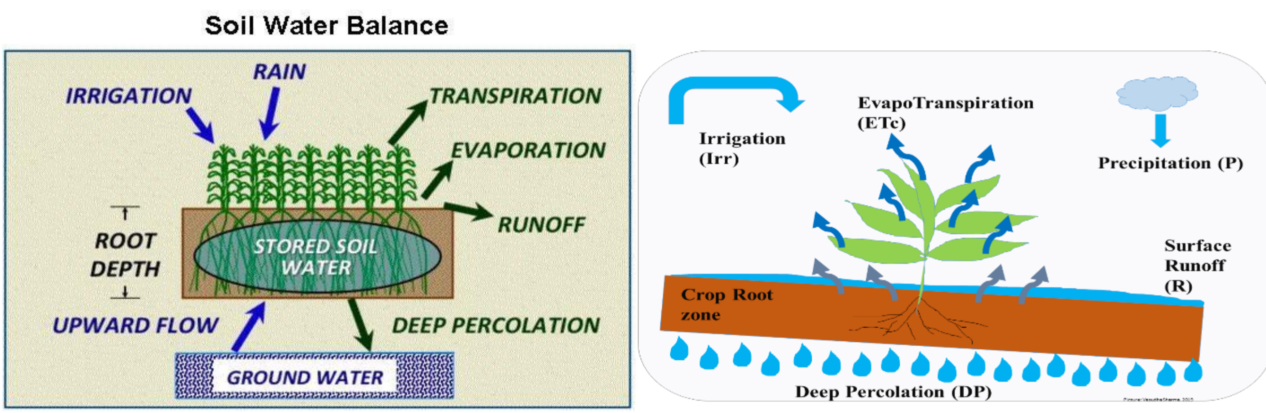


Fig 4: Evapotranspiration in the crop water budget

Evaporation from a water or soil surface is driven by six main factors; wind speed, solar radiation, air humidity temperature, surface area and the salinity (to some extent). There are many empirical equations that have been developed to help determine the evaporation of water from an open surface, such as a dam or lake. Such equations are relatively straightforward compared to the equations used to estimate evapotranspiration from vegetated surfaces since the specific characteristics of a given vegetation will affect the transpiration rate in this case.

Different plants or crops have inherent different rates of evapotranspiration because of difference in leaf size and geometry, size of the stomata, roughness of the leaves hence the aerodynamic resistance, as well as height above the ground. Additionally, the rate of evapotranspiration will vary over time depending on the environmental and growth factors (wind speed, air humidity, temperature, leaf area and solar radiation intensity).

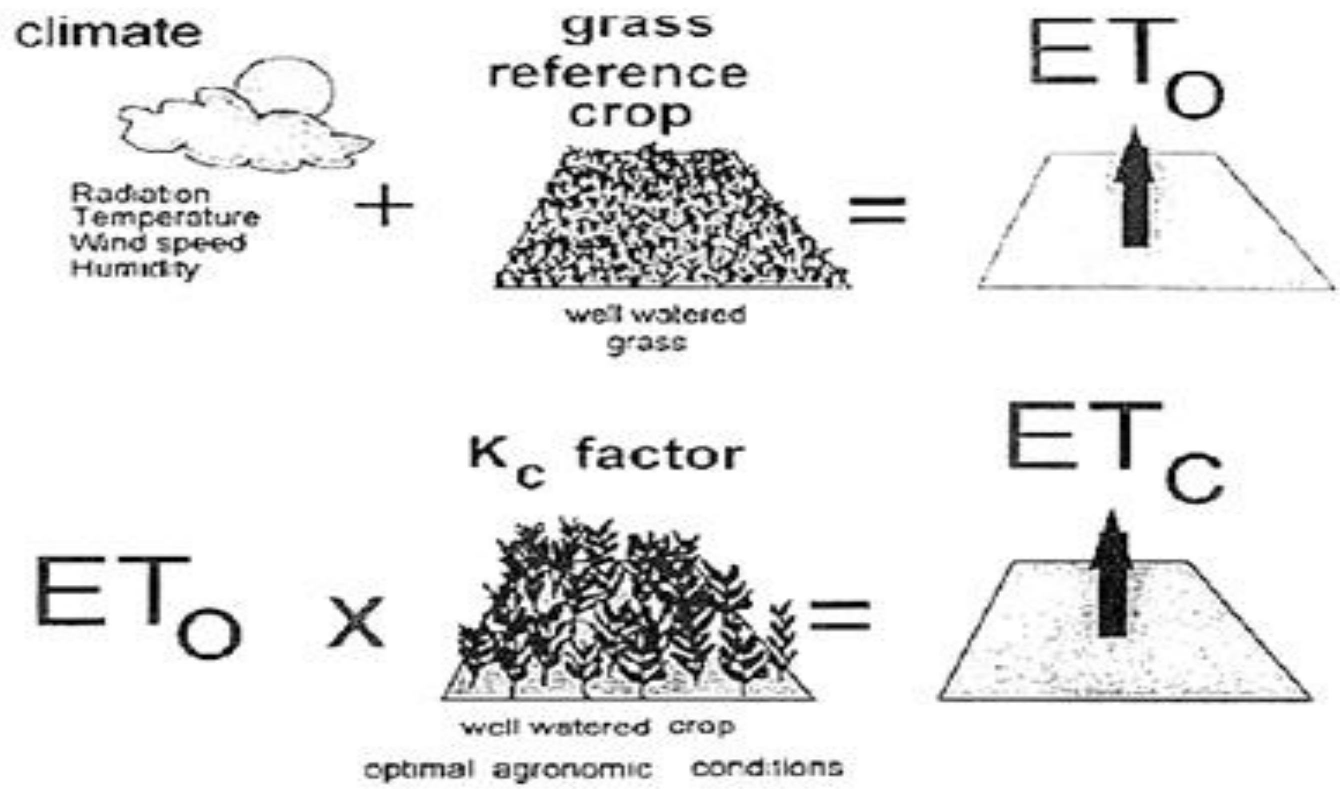


Fig. 5. Determination of Reference Evapotranspiration and Crop Evapotranspiration (ETcrop)

The traditional method of determining evapotranspiration is the water balance method on a lysimeter platform. However, models for estimating crop evapotranspiration have also been developed. The famous FAO Penman-Monteith equation has been developed to help estimate evapotranspiration for different crops growing in different climatic zones and at different growth stages. But note that there are hardly any models for predicting the water use for uncultivated plants. And there are hundreds of thousands of plant species in the world, apart from crops. Another approach, the eddy covariance method that has recently been used in predicting evapotranspiration in micro-meteorology still exhibits large deviations from the well-established measurement approaches.

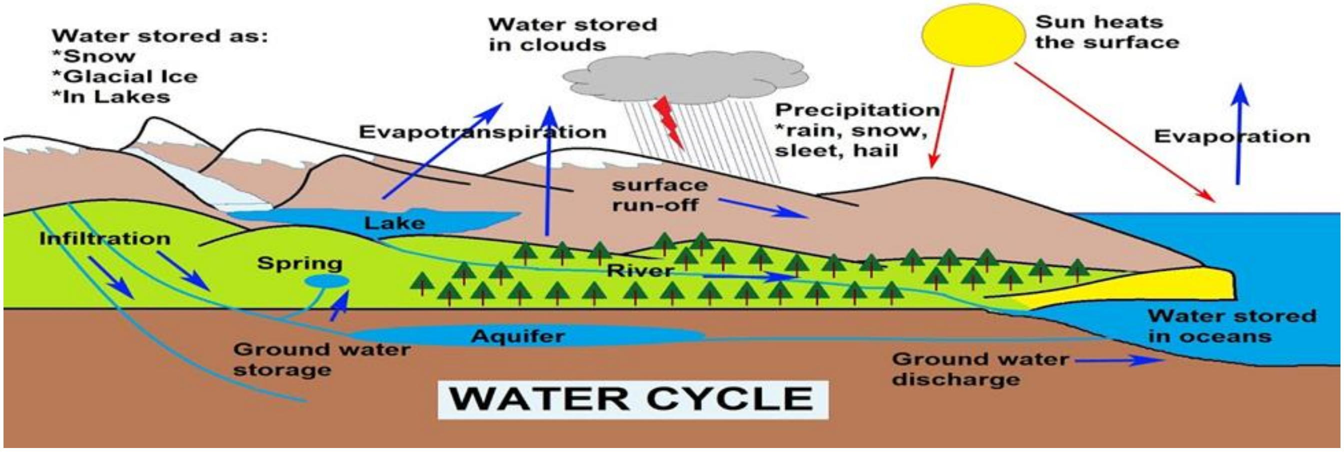


Fig 6: Conventional illustration of the water cycle

The most accurate approach for scientific prediction of climate is based on the energy and mass balance method which is derived from the First Law of Thermodynamics. It is a process-based (mechanistic) approach that has evapotranspiration as one of the core inputs. This has severally been implemented in MATLAB/SIMULINK by many authors, in addition to other software platforms. When applied over a large control volume, the energy and mass balance approach suffer from inaccuracy due the prevalence of microclimatic nodes within the volume. It has a scale and complexity limitation. Secondly, the evapotranspiration equations can hardly be applied to predict the atmospheric water budget because of the inherent differences between plants making the models prone to wide generalizations. Hence the contribution of evapotranspiration to climate, though very important, cannot be accurately predicted.

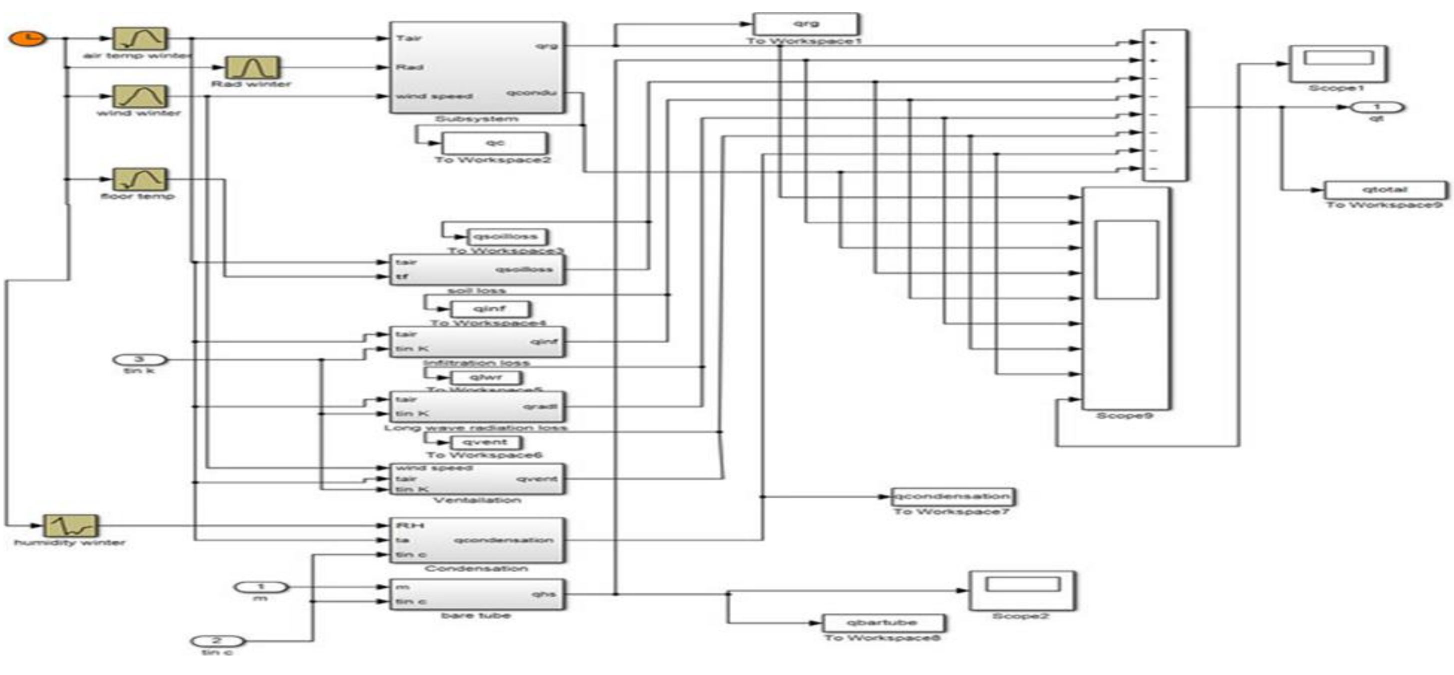


Fig 7: General schematic of mathematical modelling of a greenhouse using MATLAB/SIMULINK

So where does this leave the numerous scientific efforts aimed at understanding and predicting regional and global climate? Should such noble efforts be discarded? Do climate prediction scientists portend unnecessary angst? Well, I think micro-scale climate prediction such as for agricultural and human buildings is still sensible as it helps us mitigate and adapt to the consequences of natural and anthropogenic (human) effects on our habitats and ecosystems. Equally important are the prediction of effects of climate and land-use changes on catchment processes. However, long-term meso-scale (regional) predictions suffer a lot of inaccuracy despite consuming so much money and should be discarded.

Yet studying evapotranspiration and climate will always be important in national and international development. Activities aimed at improving or maintaining the micro-climate of a region such as afforestation, soil conservation, controlled stocking rates, land-use planning and erosion control are still important in mitigating risks. Equally we must also adapt to apparent changes through water-saving irrigation, greenhouse technology, flood control structures, water harvesting, minimum tillage, better plant varieties and other appropriate technologies.

There still exists a lot of unsubstantiated allegations about the effects of greenhouse gas emissions on current and future global climate. These claims are based on fairly sophisticated models for which evapotranspiration is a core input. These projections should not buffet us with too much angst because of their inability to accurately account for evapotranspiration, amongst other factors.

Dr. Patrick Ajwang' is a Senior Lecturer in Agricultural and Biosystems Engineering at JKUAT and is a Fellow of the Kenya Society of Biological, Environmental and Agricultural Engineers.

Kenyatta University Biosystems Engineering Chapter (KUBEC) Launch

A Picture of KUBEC Leaders, Patrons, Alumni and KeSEBAE Representatives.

Yvonne Madahana (left), Eng. Mwamzali (Center) and Redempta, KUBEC president during the launch.

Cutting of cake

The launch Kenyatta University Biosystems Engineering Chapter was held on Wednesday, 28 October 2022 at Kenyatta University (BSSC). The meeting was graced by the attendance of few members from the KeSEBAE Executive Meeting namely Eng. Shiribwa Mwamzali, Honorary Secretary and Yvonne Madahana, Administrative Assistant.

The event begun with a touching opening remarks from the Biosystems student leaders, patrons and alumni. Dr Fidelis Kilonzo, Chairman of Agricultural and Biosystems Engineering gave his speech after, highlighting some of the achievement he had made since he took office in 2019. Which includes accreditation, increase in the number of students admitted to study Agricultural and Biosystems course by KUCCPS and rise in the number of students with patented projects among other things.

Yvonne Madahana briefed the students and the lecturers about the history, objectives, and membership of KeSEBAE. She encouraged the students and lecturers to register to be members and managed to register a few.

Eng. Mwamzali who was the Guest Speaker, talked more on the KeSEBAE membership category and opportunities the Society offers such KeSEBAE Newsletter and the JEAE.

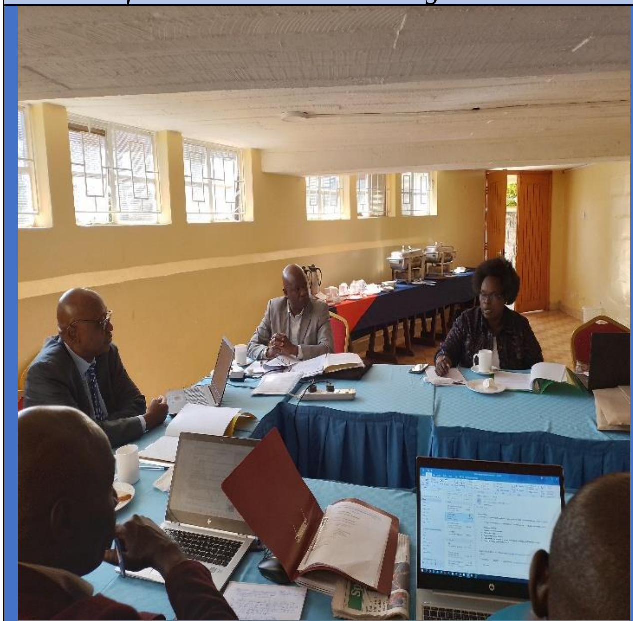
He mentioned that the knowledge and skills gained in school prepped engineers for any field in the industry giving examples of Mike Bloomberg, Dan Atambo and himself. Eng. Mwamzali then took the students through the process of becoming of a professional engineer under the Engineers Act 2011.

KeSEBAE Executive Committee Meeting

The Kenya Society of Environmental, Biological and Agricultural Engineers (KeSEBAE) executive committee, held a meeting on Thursday 29 September 2022 from 10:00 am at the United Kenya Club. The meeting recorded an attendance of seven (7) members of the committee.

The meeting kicked off by an auspicious address by the chairperson, Eng. Prof. Lawrence Gumbe. Among issues discussed by members were the upcoming conference, Webinars, Visits, JEAE publications, office fundraising and KeSEBAE engagement with PASAE among other things. Committees were also given an opportunity to present their reports. The Young Engineering Chapter Committee and the Business Executive Committee were two very propitious committee.

Picture of Members Present During the Executive Committee Meeting



Eng. Prof. Gumbe (right), Eng. Mwamzali (centre) and Eng. Jedidah Maina (left)

Catherine Ndumia(left), Ezekiel Oranga (centre) and Eng. Amos Kiptanui(left)

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JEAE

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The JEAE Editorial Board wishes to invite interested researchers with complete work in any relevant topic, to submit their papers for publication in the next editions of the Journal.

Manuscripts may be submitted online or via email to:

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Priority in the selection of articles for publication is that the articles:

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b. Are relevant to the application of engineering and technology in agriculture, the environment and biological systems
c. Have not been previously published elsewhere, or, if previously published are supported by a copyright permission
d. Deals with theoretical, practical and adoptable innovations applicable to engineering and technology in agriculture, the environment and biological systems
e. Have a 150 to250 words abstract, preceding the main body of the article
f. The abstract should be followed by the list of 4 to 8 "Key Words"
g. Manuscript should be single-spaced, under 4,000 words (approximately equivalent to 5-6 pages of A4-size paper)
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KeSEBAE NEWS Editorial wishes to call for topical articles for publication in future editions of KeSEBAE NEWS.

Please transmit the same to the **Editor: Ezekiel Oranga** via Email: info@kesebae.or.ke

NOTE: A payment will be made to the author of each selected article

CALL FOR MEMBERSHIP

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The annual subscription fees, admission fees and reinstatement fees for members of all grades (except Honorary and Life Members who shall pay no dues or fees) are indicated below: The annual dues are as follows:

Membership Category	Annual Subscription (KES)	Admission Fees (KES)	Reinstatement Fees (KES)
Fellow	5,000	1,000	2,000
Member	2,000	1,000	2,000
Ass.Member	1,000	1,000	2,000
Aff.Member	500	1,000	2,000
Student	300	100	-

Membership Renewal

Members of all grades are requested to renew their **2022 membership as follows.**

Membership Category	*Annual Subscription Fee (KES)*
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Member	**2,000**
Ass. Member	**1,000**
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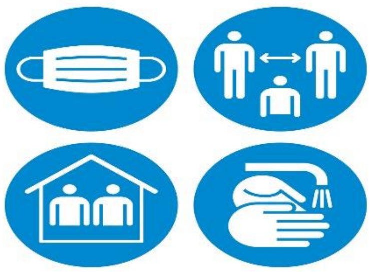

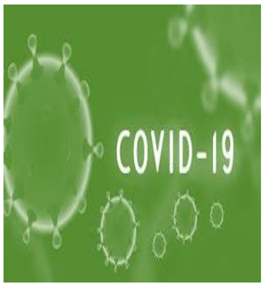

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