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MILLET AS AN ALTERNATIVE TO ALL CEREALS (ПРОСО ЯК АЛЬТЕРНАТИВА ВСІМ ЗЛАКОВИХ)

У статті розглянуте питання глобального потепління із-за випадів парникових газів в атмосферу, та вирішення цієї проблеми.

***Ключові слова**: зміни клімату, клімат, врожай зернових культур, просо, ефективність вирощування проса, глобальне потепління*

The article discusses the issue of global warming due to greenhouse gas emissions into the atmosphere and solutions to this problem.

***Keywords**: climate change; cereal crop yield; millet, efficiency of millet cultivation, global warming*

Millets, and especially pearl millet, are considered to be the most drought-tolerant among the major cereal grain crops (e.g., wheat, maize, paddy). As studies have shown, the cultivation of rice will move to the regions that are warming-up (traditionally temperate zones) as global temperatures increase in Asian countries like China, and India. To compensate for the loss of the rice crop, Millets could be grown in the resulting drylands as a result of their strong root system, which helps them to tolerate water stresses [4]. Moreover, millets need little to no fertilizers.

Millet is a C4 crop, meaning it has the ability to fix carbon at a lower transpiration rate compared to other cereal crops [1]. Millets can adapt to various soil environments (sandy, acidic and alkaline soils, and acidic soils) with a wide range of soil pH between 4.5 to 8.0 [2].

Apart from the ability to fix carbon, research has showed that the C4 crops (including maize) have various other advantages. Firstly, reports have shown that the projected rate of yield decline in C4 crops is much smaller compared to C3 crops like rice and wheat. This is primarily due ot their tolerance towards low moisture atmosphere.

The water use efficiency is 150–400% higher in C4 crops compared to C3 crops [2]. Secondly, C4 crops have a lower photo-respiration under increased CO_2 and temperature in the atmosphere, which are predicted to be the result of global warming [5]. Some modeling studies have suggested that by using improved and water-efficient irrigation technologies in the future, the yields of C4 crops can be increased by up to 38% under the predicted climatic conditions in few areas, whereas the yields of C3 crops will have no significant change [2].

Though there are various C4 crops, millets are more environment-friendly because they release less greenhouse gases when compared to other cereal crops and climate change effects appear to have less influence on millet yields.

Sorghum is another drought-tolerant crop, which is mostly attributed to its dense and prolific root system, ability to maintain relatively high levels of stomatal conductance, maintenance of internal tissue water potential through osmotic adjustment, and phenological plasticity [1].

Furthermore, millet is already grown in the various tropical countries of Asia, Africa, and to a lesser extent South America (**Figure 1**).

Hence, by educating the local growers, introducing policy changes and technological interventions to reduce the work-load on farmers could ultimately increase the production of millets in these areas. It is pertinent to concentrate in these regions as the majority of the world population now lives in tropical climates where climate change can directly impact the crop yields, production rates, hydrological balance, temperature, and soil quality [3].

Thus, increasing the area of land used to grow tolerant cereal crops (e.g., millet and sorghum) is a vital strategy for reducing the influence of climate change, issues of water shortage, and food security.

This review summarizes the growing requirements of different cereal crops and influences of climate change on the yields of various cereal crops around the world. Breeding and irrigation techniques were presented as solutions to address these issues and challenges caused by global warming.

Climate change and especially the increase in ambient temperatures will reduce the yields of major cereal crops. Hence, to achieve our goals of food security, we need to emphasize the use and production of food crops that can withstand the on-going changes to the climate to replace or be an alternative to the current major cereal crops, especially in the arid and semi-arid regions around the globe that are at a greater risk of food insecurity. Millet is one such crop that is tolerant to increasing temperatures and has the ability to grow in subpar quality soils.

Furthermore, millet production can help to mitigate climate change since it emits less greenhouse gases than other cereal crops, and has less environmental impact since it requires little or no input of fertilizer and water while growing on marginal land. Therefore, efforts should be made to encourage farmers to grow these crops and to increase their market value, especially in developing countries. Researchers and growers should develop diversification stratergies based on local conditions.

This should be part of the strategy for achieving food security within the context of climate change and a rapidly increasing population. Furthermore, it has to be noted that an holistic approach is required in tackling food insecurity issue as there is no single solution that can solve the issue.

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