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Ecological Benefits of Trees as Windbreaks and Shelterbelts

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Abstract As a result of scarce vegetation cover that can alter the movement of wind, dryland areas are predominantly windy. Harsh winds can remove moisture from plants, soils and the micro climate. Wind can also be an agent of soils erosion and land degradation. Agricultural production systems, local ecology, living conditions, etc. can often be improved by planting trees as windbreaks and shelterbelts. Research findings indicated that windbreaks as part of their ecological role, have contributed to the increase crop yields by 25%, pasture yields by 20-30%, and dairy milk production have exhibited a 10-20% improvement. This approach has also a tremendous positive impact on the wellbeing of wildlife as it will help in giving food, cover and space to wild animals. Apart from this, windbreaks can also be a viable source of edible fruits, honey, firewood, fodder and timber. Hence, the conservation of remaining vegetation in the environment and the establishment of windbreaks and shelterbelts will help to increase agricultural productivity and biodiversity benefits for the agrarian communities. Since this and other ecological functions have a paramount importance, the role of trees as windbreaks and shelterbelts needs to be further considered and properly understood. Therefore, this paper is aimed at exploring the ecological role of trees as windbreaks and shelterbelts their benefits for increased agricultural production and maintaining biodiversity.

Keywords Ecology, Agriculture, Wildlife, Shelterbelts, Trees, Windbreaks

1. Introduction

The average temperature of the planet earth has risen by 1.5°F during the last century. It is also expected to rise another 0.5 to 8.6°F in the upcoming hundred years. Slight variations in the average temperature of the planet earth can easily be transformed to disastrous alterations of weather and climatic conditions (EPA, 2015).

Climate change is now globally acknowledged as the highest environmental and fundamental human development challenge facing the world in the 21st century (UNEP, 2012). Harsh climatic conditions are happening in different parts of the world affecting and threatening the basic necessities of life for people. The planet is experiencing tangible changes of climate causing wind, flood, drought, plant and animal disease outbreaks, etc. These changes in climate will most likely cause more threats to the living organisms of earth through the reduction of biodiversity and ecosystem services that provide such as food, fresh water, clean air, fuel, timber and fiber, soil protection, regulate climate, disaster risk reduction and carbon sequestration. Agricultural productivity and production is also decreasing as a result of increased temperatures, impacts of wind coupled with increased evaporation, decreased moisture availability, increased runoff and soil erosion.

Various measures however, can help to combat the negative impacts of harsh climatic conditions. Trees do have a lot of ecological roles which can help to ease the wellbeing of living organisms. It can primarily help to reduce air pollution, create conducive microclimate and help to intensify the value of land and its related properties. Trees will also create conducive ecosystem and habitat for wild animals and birds which has a role to play on ecosystem services.

Windbreaks and shelterbelts are tree plantings with a single or multiple of trees and shrubs which are established in a variety of settings, like rangelands, cropland, roadside, etc. in order to reduce the velocity of wind. Among other benefits, windbreaks and shelterbelts will give a protection from wind, reduce evapotranspiration from crop lands, reducing transpiration from plants, controls blowing snow, habitat for wildlife, shelter for honeybees, energy saving, aesthetic value, etc. (UM, 2012; USDA, 1997; FAO, 1989; Jai, 2010).

2. Objective

This paper is aimed at exploring the ecological role of trees as windbreaks and shelterbelts their benefits for increased agricultural production and maintaining biodiversity.

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3. Results and Discussion

3.1. Definition and Scope of Windbreaks and Shelterbelts

UM (2012) defined windbreaks as plantings of single or multiple rows of trees or shrubs that are established for one or more environmental purposes. Purposes of windbreaks include: wind protection, controlling blowing and drifting snow, wildlife habitat establishment, energy saving, living screens, odor abatement and more. FAO (1989) also defined windbreaks and shelterbelts as barriers of trees or shrubs that are planted to reduce wind velocities and, as a result, reduce evapotranspiration and prevent wind erosion; they frequently provide direct benefits to agricultural crops, resulting in higher yields, and provide shelter to livestock, grazing lands, and farms.

3.2. Design

In planning to establish windbreak and shelterbelt, three distinct zones should be considered, this includes; the windward side (the area where the wind blows from), the leeward side (where the wind passes), and lastly the protected area. Permeability is the prime factor which influences the efficiency of windbreaks. Research findings indicate that, properly established windbreaks and shelterbelts are believed to protect a distance of 20 times of its height on the leeward side and 5-10 times the height of the tall tree on windward side (FAO, 1989; Jai 2010).

Different factors need to be considered when establishing windbreaks and shelterbelts, amongst the selection of trees which best suits the local climatic and soil related factors, spacing, season of planting, planting techniques, land preparation and management are some of the issues that needs to be given a due consideration.

3.3. Agricultural Benefits of Windbreaks and Shelterbelts

Well established windbreaks and shelterbelts are effective means of sheltering the leeward side from harsh winds by reducing wind erosion, protecting crops from physical damage, managing the effects of snow, by improving the efficiency of irrigation (USDA, 1997). Richard and James (2007) mentioned that 40 percent dense windbreaks will offer satisfactory protection for crops, whereas windbreaks that have 60% density are effective in controlling wind erosion. Nitrogen fixing trees are also believed to contribute the productivity and production of the nearby crop land in an organic way of agricultural production. Some trees are also believed to play as a natural repellant to crop pest and rodents. The water use efficiency of the crop land will also be intensified as excessive evaporation and transpiration will be reduced drastically on the leeward side as a result of the reduced wind speed by the windbreaks.

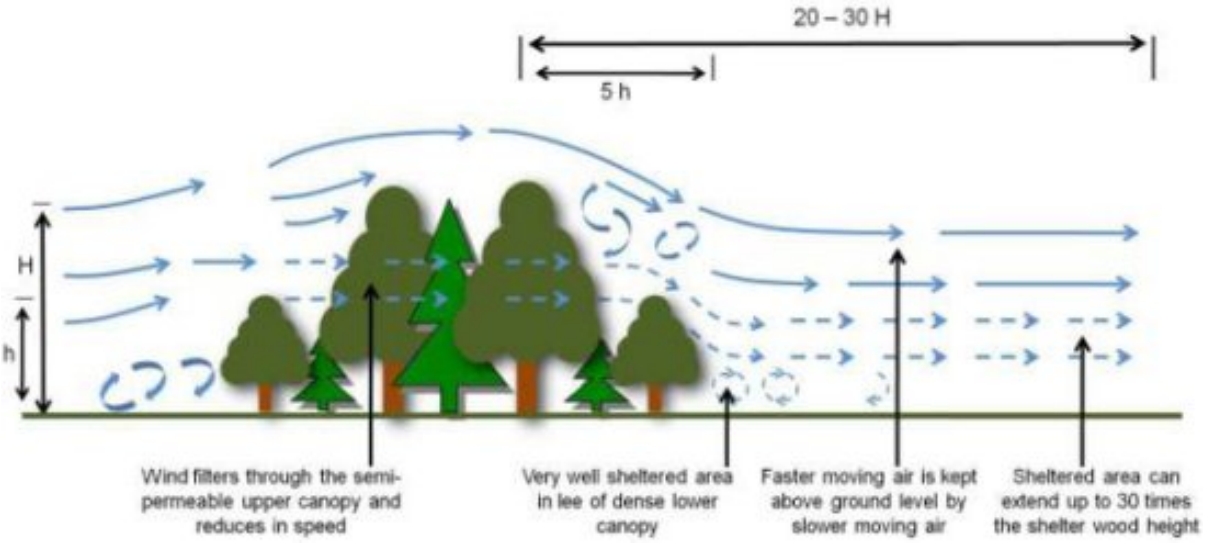


Figure 1. Windbreak and shelterbelt design (UH, 2011)

Table 1. Density of Planting

Density	25-50% density	50-65% density	65+% density
Protection	Crop, Soil Snow Distribution	Air Snow Accumulation	Farmstead, Livestock, Noise Wildlife (10 rows)
Planting	• 1 row-deciduous shrub • 2 row-deciduous tree and deciduous shrub	• Twin row-deciduous shrub • 1 row-evergreen tree • 2 row-evergreen tree and deciduous tree • 3 row-combination of deciduous trees/s	• Twin row-evergreen tree • 3 or more row-combination of evergreen trees, deciduous trees/ shrubs

(Source: UM, 2012)

Properly managed windbreaks and shelterbelts will also play a lot of role in increasing the productivity and production of livestock. Windbreaks have a role to play in ameliorating harsh climatic conditions like temperature and hail and that will have a profound effect on the health and growth of young animals. In addition to this, forage and fodder trees can also be used as a source of feed for animals. As the wind speed is usually reduced on the leeward side, animals can enjoy a calving area too. Windbreaks also serve as odor screens for livestock production (SDDA, 2006; SDDA, 2013). In addition to this, windbreaks can also be source of edible fruits, timber and other related products.

Please note that the below research discoveries reveal facts of specific areas and may not be relate to different areas as agroclimatic factors will differ from place to place. A study done on dairy milk production showed an increment of 30% (20% as a result of improvement in the growth of pasture and 10% improvement in the production of milk) since heat stress can remarkably affect milk production by the cows. A research on sheltered lambs in South West Victoria showed a 50% reduction in losses and an increase of survival rate by 28%. In South East Australia sheltered lambs and shorn sheep also showed a 50% reduction of losses. A 31% increase of wool production was also exhibited from sheltered sheep (Peter, 2014).

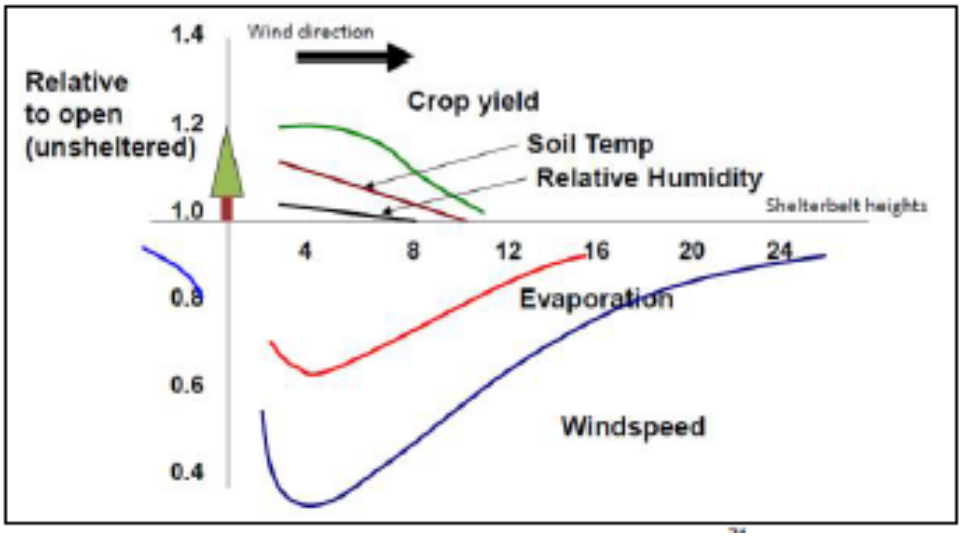
Windbreaks also have a role to play in ameliorating the microclimate, as for instance, protected areas usually warmer by 1°C to 2°C at night time (Argete and Wilson, 1989 in Brandle et al., 2004). Other ecological roles include conservation of land resources, ground water recharge, etc.

Windbreaks also increase crop production on the lee-ward side and research results in Australia showed 47% for wheat and 22% for oats. In Rutherglen, cereal crops production increased by 15%.

3.4. Wildlife and Windbreaks

Windbreaks and shelterbelts will also help to create a habitat for wild animals and birds as they can easily get the basic wild animals habitat necessities: food, cover and also space (Melissa and Amanda, 2004).

A well-established windbreak and shelterbelt can provide a space for wildlife breeding and nesting for birds. It will also serve as an efficient source of feed for the wild animals whilst providing a space from predation and harsh weather conditions. It will also help to harbor birds which will prey on the insects that can emanate from the crop land (SDDA, 2007).



The microclimate behind shelterbelts (Marshal, 1967)

Table 2. Expected benefits from shelterbelts at maturity

Benefits	Belts 500m apart	Belts 250m apart
Wind speed reduction	33%	50%
Improved plant growth	10%	20%
Reduced maintenance energy requirement of stock	10%	17.50%
Improved lamb survival (extra % units weaned)	5%	5%
Reduced losses of shorn sheep (ave. annual %)	0.50%	0.50%

Benefits from shelterbelts at maturity (Source: Bird 1996 cited in Peter, 2014)

4. Concluding Remarks

Well established and managed windbreaks and shelterbelts provide manifold benefits the efficiency of ecological and ecosystem services of land resources. Trees when used as windbreaks and shelterbelts will help to reduce wind velocities and protect crops and pastures from drying winds. They will reduce evapotranspiration and prevent wind erosion. If planned properly, nitrogen fixing trees can also provide direct benefits for increasing the productivity of agricultural crops in an organic way and by resulting higher yields. Research studies have indicated that, crop lands protected by windbreaks exhibited an increase in productivity. They will also protect livestock from cold or hot winds by providing shelter and forage. Windbreaks and shelterbelts will also help to create a habitat for wild animals and birds as they can easily get the basic wild animals habitat necessities: food, cover and space. A well-established windbreak and shelterbelt can provide a space for wildlife breeding and nesting for birds. However, the establishment of windbreaks and shelterbelts in many instances is not getting much attention for the mere fact that the growth and development period of trees usually takes time for immediate benefits. But, once established it will have a sustained and long lasting positive impact on the environment. Therefore, the use of trees as windbreaks and shelter belts needs to be encouraged by policy and strategy makers.

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