Indiscriminate Devegetation

the Root Cause of Water Crisis

Dechasa Jiru

Research Report 96

Ethiopian Institute of Agricultural Research

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ኢ.ም.ኢ፣ 2004
Website: http://www.eiar.gov.et
Tel: +251-11-6462633
Fax: +251-11-6461294
P.O.Box: 2003
Addis Ababa, Ethiopia

ISBN: 978-99944-53-78-8

Editing and design: **Abebe Kirub**
Printing: **Abesolom Kassa**
Binding and collation: **Abesolom Kassa, Miftah Argeta, and Wudnesh Mamo**
Distribution: **Solomon Tsega, Bogalech Abebe, and Meseret Kebede**

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~~Indiscriminate Devegetation Root Cause for Surface and Ground Water Crisis in Ethiopia~~

~~Dechasa Jiru~~

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Introduction

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Major effects for the agricultural production crisis in Ethiopia are backward agricultural implements and large number of animals that graze and browse freely which has caused soil and nutrient loss due to erosion. Conservation oriented development in food feed, wood and water supply under proper land use with special focus on perennial plant is an urgent need. Crop production, animal rearing, and tree planting are analyzed from proper farming land use potential perspective. Traditional role of model farming systems in wet and dry agro ecology of Ethiopia is reviewed and compared with present improper practice. The role of trees and grass cover in sustaining surface and underground water balance in the hydrologic cycle is presented. Research results of a role of dominant trees on farm: *Afrocarpus falcatus* a common soft timber species, *Juniperus procera* a widely growing durable timber tree and *Cordia africana* a common tree on farm, in intercepting rainfall in 2006 rainy season are presented.

It is intended to initiate interdisciplinary approach for water and natural resource conservation, sustainability and development from proper land use and environmental conservation using trees on farm as an entry. A model has been further demonstration as an input to enrich the integrated water development national strategic plan.

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Agroecology-based Approach

The lack of integrated approach—specialization of professionals in narrow portion of live science only (Reid 1990) brings about a critical gap in agricultural development. A discipline that integrates the major agricultural sector is agroforestry. According to International Council for Research in Agroforestry (ICRAF, 1990): Agroforestry "refers to a dynamic, ecologically based, natural resource management system that, through the integration of trees in farms and agricultural landscape, diversifies and sustains the production for increased social, economic and environmental benefits for land users at all level (Simite *et al.* 1994) gives a description in (Danforth, Noren 1994). Agroforestry is a deliberate interaction between environmental component, management strategy, crop, livestock, forestry, and land in economically viable, socially acceptable and environmentally sound in scientific, artistic, and business approachs for the benefit of people. Agroforestry is an interaction of environment, management strategy, agriculture and forestry component and land to avail and sustain basic human need.

Ethiopia is known to be the "roof of Africa," on one hand it is unique as an opportunity, on the other hand improper farming management and devegatation has constrained the system and the subsequent productivity.

As a contrast - Australia is one of the best exemplary models in being competent on harsh and arid conditions and in poorest soil country. In

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reality the agroecology uniqueness and diversity in the highlands of Ethiopia is not a challenge it is more of an opportunity if we correctly understood the root causes of the problem and takes appropriate mitigation measures.

In Ethiopia climatic and edaphic information, on factors determining potential productivity ~~(~~like soil moisture and nutrient, humidity, temperature, and sunlight~~)~~ is so far generated for shallow rooted and short height annual crops cultivated in open flat landscape. Such basic information is reliable to a large scale mechanized farm of same representation. But the predominating land form conditions are hilly, rugged, depressions, gorges, pockets, sharp hill tops and multi-storey closed and open forests and bushy landscapes. Therefore such a limited basic information service marginalizes the majority of the farm and the farmers. In higher elevations and in frost pocket areas dry wind and cold temperatures are critical and are causes for animal and plant loses (Reid, Bird 1990). In such conditions shade and shelter effects of trees in establishing temperature and reduction of desiccation has positive impact on crop and animal production. Ethiopia being a highland is severely prone to cold temperature.

Acacia tree canopy intercept 52% of rain water and allow 48% to reach the ground upon reducing its acceleration and droplet size and there by increased rate of infiltration (~~Yilma 2002 referred in~~ Dechasa 2004). The intercepted rain directly evaporates to the air and increase air microenvironment humidity that can lead to increased rainfall amount of the upcoming days of the higher slopes.

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The phenomena of sharp reduction in minimum temperature occurred in Ethiopia in October and January, has brought a dramatic frost effect on an over century naturalized exotics eucalyptus. . Similar harsh climatic events compounded by the shift in wind direction that had killed 30 000 newly shorn wool sheep brought Australians to overcome the problem by planting wind break in all direction as a shelter and windbreak ~~(Cremer. 1990).~~. The following potential productivity of the highland is determined both for edaphic and climatic from data generated in the open and flat land.. Thus, it is not relevant for perennial crops like coffee, forest or fruit trees and land forms outside flat land and open. Current data on plant water relation and ecohydrological information are irrelevant. Preliminary, applicable climatic zonation is the Australian classification. The precision of the system can be justified from its sensitivity of rejecting the Ethiopian highland shown by a blank "bird" shape while the entire African continent has been classified perfectly.

In a forest area the temperature is stable and there is no risk of extremes endangering crop or animal production.

The perennial plants which are in focus, growing taller in the air and deeper in the soil have different climatic and edaphic requirements, than shallow rooted crops. Relevant basic information applicable in cultivation of such plants is missing. Such critical gap should also be filled with an integrated interdisciplinary approach.

Trees in natural forests and in plantations are depleted while the number of on farm trees increases ~~(World Agroforest 2010 personal~~

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~~communication).~~. Thus it is strategic and worth focusing on trees on farm. Soil degradation and erosion is predominantly caused on arable and grazing land of ox-culture farming. Free grazing systems cause devastation of trees and subsequent nutrient depletion and famine (Dechasa 2003).

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Mono and Shallow-rooted Crop Production

Agricultural production and productivity is a function of space and time in which the plants grow. It underlines the contribution of perennial plants in sustaining productivity from livelihood and environmental protection perspectives. In the highland tropics the modified temperature ranging from 10 to 35^{o}C (EPA 2008) would have been an opportunity but it had been masked by improper farming practice that devastated forests in search of more cultivated and grazing land. The resource allocated for forestry and animal research is far below potential contribution compared to the crop sector. The most limited resources constraining agricultural productivity are moisture and minerals. The "green solution" is a proper management of the watershed ~~(~~not the grey annual crops and grasses that remain gray for nine months and is green for only 3 months under rain fed production system~~)~~.

Annual crops grow in very limited temporal and spatial terms. Potential productivity is a function of heat light trapped and carbon-dioxide, moisture and mineral absorbed by plants (Tur~~n~~vey, ~~D.R.~~ 1900). Since it is a function of spatial and temporal factors, the perennial plant has the highest productivity as illustrated below.It is simple to imagine and forecast the consequence. If we draw a conceptual line joining the tip of the root and the tip of the shoot of a plant upper canopy tip, to the

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respective end of mono-cropping, the two strait lines drawn in the air and underground will eventually join on the surface in point, where the land is not able to support any plant growth. At this intersection point the yield is zero. Beyond the intersection the land it still supports the so called "negative growth",," we see some pseudo growth (the exposed rock developed by severe erosion). (Fig.1). Such phenomena causes floods, fill lakes and dam that charges one from reserve or expose the property owner to loan. The underground and surface water resources sustainability and quality are affected firstly at that wrong practice. In general different professionals, private investors, and policy makers support falls in different categories as shown in the table attached.

Musa enset is a perennial crop (rich in carbohydrates) which grows in an open area. On the contrary *Cordia african* the best quality timber tree cannot stand direct sun exposure - since the apical shoot dies, the branches fail to produce strait poles. Therefore a traditional complementary production relation works out under perennial intercropping (Fig. 2.) which currently is one of the options in production of the two species in a green revolution technology.

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Naturalists, Foresters	Agroforesters, Mixed cropper farmers, Coffee and enset based farmers	Private investors, policymakers, agronomists, economists	Zone where stone(non living thing) grows
Green revolution	Green-grey revolution	Grey revolution	Drought and absolute famine

Fig. 1. Summarizing the risk of annual mono cropping comparative of multistorey, ox culture monocropping impact on productivity

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Fig.2. The best timber tree *Cordia african* can be grown strait in the best perennial food crop *Musa enset*

In the past, good crop-mixing practices in annual cropping system in central and northern parts of Ethiopia consists the combination of different oil and vegetable crops. They are of variable vegetation type, root depth, and height and reach maturity at different times. The common ones are suff flower and cabbage (mustard) mixed in common small cereal called tef, Fig. 3.) Such mixed production brings about product optimization in terms of spatial and temporal dimension. It

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boosts organic food production and productivity and averts risk through diversification. Unfortunately, now the practice is compromised by high yielding single crop farming which however can not alleviate food shortage due to storage problems, adaptability, and quality.

Fig. 3. Traditional farming in central and northern Ethiopia - mixing of different annual cereal and oil crops

Such practice of different root and shoot reach level both above and below ground optimizes the above ground resource input, moisture, and minerals absorption to sustain and boost productivity at even annual crop level (grey revolution). The *Acacia albida* tree intercrop increases sorghum, maize, wheat and tef (a tiny major cereal) yield by 100, 70, 40 and 10% respectively, compared to sole cropping (Dechasa 1995). In addition it provides 1.7 cubic meter solid wood from pollarded branches for fuel which can substitute 1.2 ton of cow dung or 1.4 ton of crop residue) annually. The pollarded branch yields 0.5 ton of fresh leaves

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and twigs per year from 50 trees per hectare, to supplement animal feed per year on average in Ethiopia (Dechasa 2004). Figure 4 illustrates the mean yield increase of different sizes of cereals at different distance from *Acacia albida*. For optimum average yield 100 tree per ha can be planted and has to be thinned to 50 trees /ha when the reach 50cm diameter.

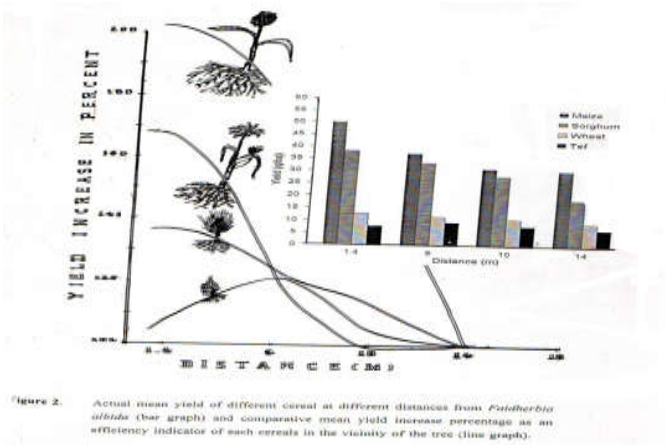

Figure 2. Actual mean yield of different cereal at different distances from *Faidherbia albida* (bar graph) and comparative mean yield increase percentage as an efficiency indicator of each cereals in the vicinity of the tree (line graph).

Fig. 4. Comparative yield increase of cereals in the vicinity of *Acacia albida* (Source Dechasa 1995)

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Trees and Hydrology

In Maize growing dry farming of Central Rift Valley there is repeated crop failure under rain fed condition. In contrast, under canopy despite lower amount rain water reaching the ground due to canopy interception and absorption of a part of soil moisture by the perennial tree transpiration, the final amount of soil water under the shade in dry season is 1.5 to 2 times higher than that of open area (Kamara and Hauque 1992).Wood from 50 trees/ha of optimum spacing yielded 8.4m^2 in five years which can substitute 6 tons of dry cow dung or 7 tons of crop residue. Saving cow dung means using cow manure as organic fertilizer that increases moisture holding capacity of the soil for better productivity. The residue is also used as animal feed and subsequently increase cow manure out put. Had there not been a tree on a farm means more deforestation for fuel wood.

Currently maize yield increase reached 300% ~~(World Agroforest)~~. In the faces of expansion of chemical fertilizers such traditional tree farming and potable underground waster are under threat.

The tree tap root can reach underground water as deep as 170 meters ~~(personal observation)~~. It constitutes a good salinity protection in dry irrigation.

The following four trees are found on black vertisols. Bore holes at the base serves to measure fluctuating water table in wet and dry season. At

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15m depth which is accessed by their tap roots. There are four others trees in each treatment with 10, 15, 25 and 30 meter deep *Acacia albida* water relation treatment on farm ecohydrology research (Fig 5). There are four control bore holes for each of the above treatment which are located and bored in the open. This research is a basic that addresses why it shed its leaf in rainy season. Scientists have ramified views and there are two hypotheses. The first one says the tree spread north during African cold weather. It adopted the Mediterranean vegetation phenology and shed its leaf during winter. When the climate changed it fail to change with the change. These groups of scientists are challenged by the failure of other species in exhibiting similar character. The second hypothesis is rather stronger it says "the tree can accesses water table and can grow in dry season. On the contrary it loses its leaves during rainy season because the soil substrate is in its water field capacity, thus oxygen supply is cut ~~off~~off, and the tree is forced to go into dormancy. The ongoing experiment is partly to proof the second hypothesis has also shoed a lose correlation. It is rather the physical force of the rain drops that shades the leaves at the onset of the rain which is a third hypothesis which the presenter.

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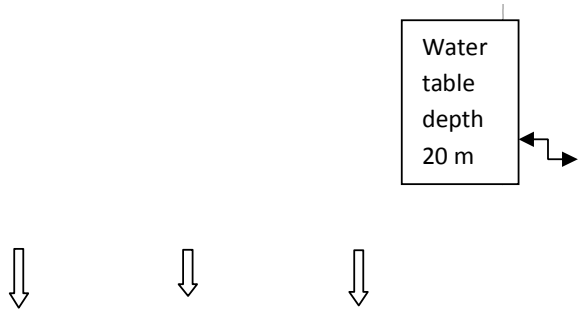

Fig. 5. *Acacia albida* tree intercrop without leaf in the rainy season.
~~(**Source** Dechasa on farm ongoing research on ecohydology phonological research)~~

If a tree accesses water table the level increase in the highland and decreases in low land due to temperature effect (Fig 6)

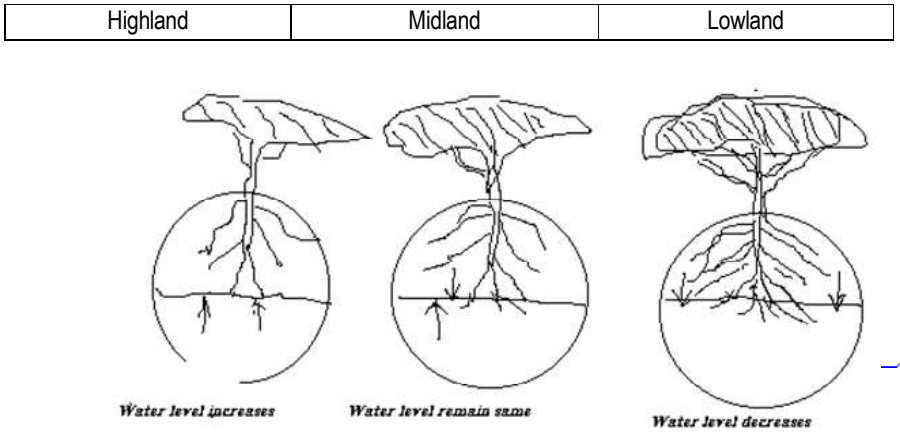

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Fig. 6. Relative underground water absorbing capacity of deep rooted tree
~~(Dechasa unpublished result from bore holes of *Acacia albida*)~~

Trees can combat salinity because of the following reasons-:.

- the presence of deep rooted trees reduce salty water table down;
- removal of trees like *Acacia albida* and replacement with Shallow rooted crops of pasture will increase the volume of water recharge to the ground water; and
- ot results in salt-water rise to the surface and causes salinity especially in lowland warmer area.

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Land Ownership and Forest Management

Lack of ownership security threatens the development of forest in any country. In Ethiopia some community based participatory forest management practices have been started in some places. It has not been applied on a larger scale; land ownership is still not addressed.

Such improper farming is the root cause of the problem of surface and underground water balance, water sanitation and sustainability crisis.

High yielding and superior quality fruit trees, perennial root tubers like cassava, multipurpose tree intercrop and tree inter-pasture technological package generation in integrated research and management are some of the biological options

Expansion of arable and range land is at the expense of indiscriminate. To combat such problems afforestation / reforestation/, participatory forest management, wildlife conservation, organic natural coffee conservation as forest, semi-forest and home garden coffee and buffer zone afforestation, area closure especially in dry areas are desirable development effort.

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Comparative Infiltration Rates

Trees intercept gravity water in the form of capillary on its leaves and twigs. The feathery leaves break the big droplets into fine drops and enhance infiltration. Capillary soil water that is available to plants can be sustained by the tree shade effect function.

In open acacia woodland of south Ethiopia range burning is a traditional practice to boosts grass growth and quality. The range land burring was taken from natural phenomena of bush fires. In moisture scarce area the grasses in-filter rain in rainy period, and die in long dry period not depleting soil moisture and nutrients.

Woodland interception showed an intermediate infiltration, the acacia canopy intercepts 50% of rainwater, so water reaching the ground is reduces by half. But big droplets are broken in to very fine ones upon falling on feather leaves which further increases infiltration.

Increased termite population developed as an effect of aardvark population depletion and caused by broken food-chain balance due to Aardvark killing by illegal hunting resulting in termite population increase and subsequent increases bare impermeable land area of termite mound formation. This severely affects rain water infiltration and result in ultimate reduction of underground water level and aggravated flood incidence. Thus integrated pest management based on natural management system need to be strengthened to avail and sustain surface and underground water

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Need-based Tree Development

Forests area decreases, on the contrary number of trees on farm in the tropics increases. In Ethiopia the same trend is observed in rural area. Trees are cleared for crop expansion and to some extent for range land. Basing on interview information, the most important tree inter-crops and tree inter-pasture species and their role are summarized in Table I. Thus promotion of socially accepted trees on farm is a short term strategy in forest development that place role in carbon sequestration, food, feed and wood and economic security. It serves as a buffer for natural forest sustainable protection. The model was adopted from direct like wood food or feed production and indirect role of tree like environmental functions of vegetation use and derived from dry lands of Africa.

Under proper traditional or modern farming food, feed and wood security and sustainability can be achieved in most agro climatic zones of Ethiopia. To accomplish this first step is a local practice using indigenous plants. The second step is options of technologies generated by research. Affordable technology in the area of physical, biological and tradition and modern management options for water conservation and enhance and boost of production need to be adopted. Range land grass and eucalyptus stump burning, multistorey home garden cultivation, pond water harvest under shade and area closure for protection from free grazing livestock and natural regeneration, are some the indigenous practices for water sustaining and conservation.

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Grasses has the highest potential in interception and infiltering ability thus both surface and underground water sustenance is mainly determined by grasses. On the contrary tress seems low in intercepting on per yearly basis but ones it is above 10years in can intercept substantial amount of precipitation and can transpire better than grasses and can enrich sky with humidity for rain to recycle. Soil moisture can also better retain compared to grasses. Thus each type of vegetation there own specific role and need to be conserved.

Understanding the link and root causes of deforestation, drought and ultimate poverty and hunger in Ethiopia as a cause and effect is insufficient in practice. Population increase as predominant cause for land degradation is a crude generalization. It has to be examined at different farming system level in research, planning, and implementation. Now there are some positive initiatives by None Government Organizations and Government Organizations. Population increase and land degradation problems do not positively correlate according to conventional accepted norms. If we consider two similar agro ecologies one with mix perennial plant cover and the other with no perennial plant and compare population density, this paper have fundamental reasons for confusion.

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Conclusion and Recommendation

In hoe culture of perennial planting domination even if it is on stage behind ox culture food, feed, wood and sustainable water supply security has been better addressed. On the other hand, any open arable and free gazing land of similar slope, agro-ecology, and same land size of open mono cropping on hills near Mizan in the western part of Ethiopia it can only support as low as 150people/km^2. Konso is a dry agro-ecology in the South receiving less than 500mm of annual rainfall, which is not sufficient for agricultural production yet it is one of the medium level self-sufficient zone which supports over~~more than~~ 500 people/km^2. It seem exaggerated but if mono cropping of predominantly shallow rooted and short time crop production continue and we will face both famine and ecohydological crisis. Those model areas use integration of perennial trees to the main crop. Currently, regional and national tree on farm population increase is a healthy trend; however these efforts need to be linked with the global environmental initiatives under research finding Support.

Grasses has enormous potential in intercepting and infiltrating water and has to be developed for underground water recharge sustainability.

On the other hand trees can intercept and increase humidity for to intensify future rain. Thus a balance needs to be strike in conserving tree grass proportion from proper land use perspective.

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- Livestock genetic improvement and local geen feed supply and conservation together with feed and feeding management such as destocking to the actual pasture carrying capacity is an urgent task. Rotational grazing using multipurpose life fence instead of wooden post and barbed wire is also commendable from economic sustainability and environmental conservation perspective;
- Reforestation and reforestation in potential areas and area closure in dry land under integrated catchments planning is recommended;
- Promotion of multi-purpose perennial food feed plants under rain feed or irrigation in arable farming under proper land strict land use management plan;
- Industrial agriculture of high value and large scale farming need to be promoted under integrated proper land use land capability to insure the national economy;
- Researchers and developers in natural resource such as agriculture, water environment should work together under structured and centrally planed network to combat environmental crisis; and
- Joint training to develop skills knowledge and attitude should be given priority as the problem boils down to the social environment

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Acknowledgements

The author would like to thank Dr. Seyid, Betre Alemu, Tigst Reda, Mulatuwa Feyisa, Asrat Bulbula, Melaku Admasu, Kumilachew Abera, Emebet Muhamed, Alemtsehaye Eyassu, Yohanis, and staff of Ministry of Water Resources and Forestry Research Center and the Directorate of ~~information~~ Information and ~~c~~Communication of EIAR for their technical and logistics contribution to this research.

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