

Case study

Environmental Impact Assessment of Diversification of Crops in Ethiopia: A Case Study

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Abstract: Diversification of crop and farming through horticulture projects has been adopted in the country in recently to assess positive and negative environmental impact on soil, water resources, air quality and ecosystem, health and socio-economic conditions of people. By using checklist and environment Quality index the work was conducted to assess environmental impact of Tana Flora project situated 17 km from Bahir Dar town and 2.5 km from the Lake Tana. The analysis concludes a high of level impact on ecosystem, soil resources and human health, medium level on water resources, air and low level on socio-economic conditions of the surrounding population.

Key words: Horticulture, impact, bio-physical environment and society.

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Introduction

During the last decades of 20th century, Ethiopian agriculture stood at a crossroad and frustration among farmers as well as in government was inevitable. The food grains production became uneconomical due to increasing gap between input cost and output price per unit weight of its production due to increasing cost of inputs, in successive years under the influence of world economic order [1]. Reduction in the size of operational holdings year after year due to division of holdings among the heirs, drought and soil erosion have also contributed in reduction of productivity and consequently, badly affected the economic viability of some traditional crops like food grains. This critical agricultural situation called upon a drastic and constructive change in agricultural policies, and object orientation of farmers toward diversification of crop and farming systems in the country in recent decades [2, 3].

The rapidly increasing demand in developed countries has made flowers, fruits and vegetables the best exportable commodities. Ethiopia, with its naturally gifted topography, climate, and accessibility to European, Asian and Middle East markets has a huge potential to supply high quality flowers, fruits and vegetables to the world. In addition, Ethiopia has fairly constant climate that makes farming to be continued throughout the entire year. This will enable selling flower, fruits and vegetables in both the northern hemisphere and in the southern hemisphere. The opposite seasons imply two marketing cycles a year and a demand for fresh and vital flowers in all seasons [4].

The flower sector has only recently become an important agricultural sector for Ethiopia when regarding the export potential. It is a relatively new but at the same time very dynamic sector. Since 2001 up to 2007 the export value of flowers has increased from US\$ 0.3 Million up to US\$ 113 Million [5] which accounts for 7.8% of the total export value in 2007. For attracting potential foreign investors many regions have invested in infrastructure so that their agricultural land is accessible [6].

Tana Flower project PLC intends to engage in flower in to same extent in fruits and vegetables at *wangeta kebele* near zegea which is found around 17 km from Bahir Dar and 2.5 km from the Lake Tana. The site was selected considering convenience of agro-climatic character to the target of the project and its respective social and economic to the local society, region and the country in general. It is clear that such projects create job opportunity and maximize the exportable items and to increase GDP and foreign currency of the country [5]. However, it may have adverse

impact on the environment. The present work was conducted keeping the view of importance to assess positive and negative environmental and social impact of the under construction flower, fruits and vegetable project and to fulfill the practical requirement of the course Environmental Impact Assessment.

Objectives of the study

- To ensure the impacts of the horticulture project on the environmental components,
- To assess impact of the project on soil, water resources, air quality and ecosystem, and
- To describe the effect of the project on the socio-economic and health conditions of the people.

Approaches and Methods

The environmental impact study based on phases; the first phase was stated by reviewing of relevant documents of guide lines of EIA of the country and regional government of Amhara and environmental policy and law of Ethiopia. Checklist to collect data and design of successive phases of studies were prepared based on the information obtained from reviewing documents and reports of similar projects.

During the second phase available and relevant information were collected using the prepared checklists from the area of the project under construction. Visual observation was undertaken on the biophysical and socio-economic conditions of the project area and information were collected through interviewing managers and workers of the project, surrounding farmers and government organizations, i.e., Amhara regional Agricultural and rural Development Bureau, Amhara Bureau of Investment.

Based on the collected information the last phase of the study has been allocated to analyze using checklist methods. Composite environmental quality index method was also used to analyze the environmental impact of the activities of the project. Utility functions have been established for individual attributes. The first step was to calculate a scaling value (k) for each attribute. Such scaling values reflect the relative importance of the different attributes. Total utility/composite environmental quality index was determined by Bisset (1984) recommended; cited in Wathern (1995), analysis environmental impact of different environmental attributes which are going to be affected on the basis of the following formula.

$$EQI = U(x) = \sum_{i=1}^n k_i U_i(x_i)$$

Where

EQI = environmental quality index

U= Utility attributes

Ki= Scaling factor of attribute

Ui= Utility frequencies

Base line information about the project site environment

Environmental impact assessment is the methodology or instrument of identifying, analyzing and evaluating and forecast in advance any impact, be it positive or negative. It is also important to detect the change and thus to manage the environment properly.

Size and nature of the project

Tana flora intends to produce rose cut flowers fruits (mango) and vegetables for export market and domestic to some extent as the agro-climate of Ethiopia especially the select site is suitable to produce such horticultural plants. The total size of the project is 124 ha, the total land consisting 40 ha for rose cut flower, 30 ha for fruits, 25 ha for vegetables, 7.5 ha for forest wind brake trees, 20 ha green house for flower, fencing, planting selected variety of mango fruits and about 2 ha for office and residential, about

Geographical outlook

The project is located in the Amhara regional state in Bahir Dar Zuria woreda at wanjeta kebele at about 17 km from Bahir Dar city and 2.7 km from the Tana Lake. It covers a land of very gentle ($0-3^0$) constituted by volcanic rocks. The soil was composed of thick, deep and reddish lateritic soils with PH of about 5.5-6.7. However, there is a seasonal swampy area at the Tana Lake side which can recharge the ground water. But existed rocks were barrier for unprecedented overflow of the lake. Average annual rainfall was about 1463 mm. The mean rainfall was high from June to September while evaporation from water body is 1836 mm/year. The mean monthly maximum and minimum temperature varies from $23-33.5^0\text{C}$ and $6.3 -16.7^0\text{C}$ respectively. March to May are the hottest months and December to January are lowest temperate occurs.

The air environment is expressed in terms of its quality. It is clear that the proposed project site is found in the rural area where there are no industries and few vehicles pass per day. As a result the emission of air pollutants particles are to be low except some suspend dust particles because the road is concrete. There are no wild animal spices because the site is devoted for cultivation and fenced. Many indigenous trees are distracted during land preparation and some spices are planted for wind break. The economy of the area is at subsistence level mainly based on crop production and animal husbandry. The major crops produced by the farmers in the area are like

maize, finger millet and Nug. The Wanjeta *kebele* has a total area of more than 7000 ha covered by crops, grazing, settlements and forest/bushes.

Environmental Impact of the project

Environmental impacts appeared mainly during construction and operation phases of the project. Therefore based on the nature and size of this project feature of the project's environment the following issues have been identified and analyzed so as to identify the critical issues. In order to analyze the environmental impact of a project activity in more detailed approach is given in matrices, where project activities were cross-tabulated with environmental components and metric-checklists was developed into a stage with detail information and experiences to categorize the impact of the project activities on the environmental components information. The strength of the matrix approach is considered the usefulness in designing further studies [8] the inexpensive nature (also true for checklists) and their comprehensiveness.

Checklist for impact of the project activities on the environmental components

Environmental Attributes	Project Activities								
	Land preparation	Construction (greenhouse)	Soil-Plot/pot preparation	Transporting raw material	Water Intake & (irrigation & drainage	Fertilizer application	Pesticide application	Waste disposal	Employment
Soil resources	srL		sL		srL	lrL	l		
Water quality		sL				li	li	l	
Surface /ground water hydrology					l	liR	liR	liR	
Air quality	sr			Sr		siR	liR	liR	
Ecosystem (flora and fauna)	lL		lL			sL	sL		
Health						liR	liR		
Socio-economic	liL								liR
Agricultural land	lrL						lL	lL	
Land use pattern	sL								lR

R= regional, r=Reversible, i= irreversible, L= local, s= shot-term, l= long-term

There was a difficulty to get a potential rigidity of categories and an overview when many variables were included. In many cases numbers of magnitude and severity of impact are included on a poor basis. Thus, many matrices used give much less and lower quality information than thought on first impression.

To avoid such types of predicaments and to analyze the environmental impact of the activities of the proposed project environmental quality index was used. Similarly methods had been used by Bisset [9], Canter [10], Maclearn [11], Lawrence [12], and Morgan [13]. Environmental quality index followed weighting scale varying from 0-1 applied logically on basis of comparative and relative importance of physical, biological and social attributes.

Weighted Quality checklist for impact of the project activities on the environment

Attributes	Parameters	Impact scale	Environmental Quality Index $\sum \frac{k_i U_i}{n}$	
Soil resources	Soil Erosion during land preparation	0.71 ±	=0.73	High
	Nutrient loss during land preparation by water/irrigation	0.9 ±		
	Use of fertilizer, pesticides and machineries may result in soil physical and chemical disturbance	0.7 ±		
	Soil Acidity	0.6 ±		
	Imbalance of biological activities as a result of contamination of soil with toxic chemicals and loss of organic nutrients due to soil pollution.	0.72 ±		
Water resources	Flooding, channel modification, canal siltation.	0.6 ±	= 0.65	Medium
	Reduction/lowering of surface or ground water table.	0.4 ±		
	Soil Water logging results from mismanagement of water resources.	0.8 ±		
	Excess increment of nutrients in water bodies (eutrophication).	0.8 ±		
	Pollution of surface and ground water through direct or indirect addition of toxic chemicals or waste or organic chemicals etc.	0.8 ±		
	Resource competition(if there is no water resources development activities)	0.5 ±		
Air pollution	Emission of gases like ammonia, methane, etc to the atmosphere	0.8 ±	= 0.68	Medium
	Reduction of air quality; endangering of life (flora, fauna) due to gas wastes.	0.7 ±		
	Depletion of ozone layer& climatic change due to emission of some gases (SO ₂ , CO ₂ , NO ₂ , fluoride, CO, CFCs) to the atmosphere	0.6 ±		
	Affecting human health and settlement	0.8 ±		
Ecosystem(flora and fauna)	Contamination or use of polluted water may affect wildlife and nearby communities to the project area.	0.7 ±	=0.7	High
	Introduction of new species or change of cultivation may cause for development of pests, diseases or weeds.	0.8 ±		
	Directly or indirect killing of aquatic and terrestrial animals Spreading of pesticide/insecticide for different purposes.	0.8 ±		
	Loss of flora and fauna can be occurred when projects are established at the spot or in vicinity	0.5 ±		
ec on o	land use and tenure conflict may occur around the project	0.4 ±	=0.6	Low
	Inundation of farmlands like loss of agricultural, forest or grazing lands by huge	0.4 ±		

Attributes	Parameters	Impact scale	Environmental Quality Index $\sum \frac{k_i U_i}{n}$	
	amount of waste generated from the project,			
	People are exposed to further social and economic crises when their farm land is occupied by project	0.9±		
	Conflict due to lack of awareness about the project and resource competition	0.8±		
	Impact on culture due to in-migration	0.5±		
	Impacts on other resources such as water, road and clinic	0.6±		
Human Health	Transmission of disease between human and from plants/animals to humans	0.4±	=0.72	High
	Fire, explosions, emission of toxic gases, vapors, dust, emission of toxic liquid, radiation and their cumulative effects badly affect human health in and around the project	0.8±		
	Occupational health effects on workers due to fugitive dust, material handling, and noise, mechanical or chemical contact can be occurred.(within the project)	0.8±		
	Death and injuries to human beings due to improper loading, storing and disposing of chemicals.	0.7±		
	Health effect due to inhaling polluted air around the project	0.9±		

Weighted method of Environmental Quality Index

Composite Assessment	Significance Level	Environmental attributes
Above ±.07	High	Ecosystem, soil resources, human health,
± .65-0.69	Medium	Water resources, air pollution,
Below ± 0.64	Low	Socio-economics

Land Development

During project activities the cutting of trees clearing of shrubs and grasses were taken place. This will have an impact on the ecosystem. Even though it is long term and less significant the erodibility of soil may be increased. But as far they level the land for plot preparation it may be reduced. The fruits and flowers which are suitable for the area and having good variety are already planted and propagated. Genetically modified seeds and planting materials would affect genetic diversity and human health and may also cause the introduction of new pests in the surrounding [14]. However, Tana Flower project PLC assures that the plants are going to be purchased from the local propagators or certified importers. The selected planting material varieties do not have any persistent character, are not resistant for biotic and abiotic factors, and other ecological risks.

Water resource (Irrigation and Drainage)

The expected impacts which are associated with irrigation and drainage:

- a) Depletion of water resources: The project will run with drip irrigation and normal irrigation system for the cut flowers and fruits which have high efficiency use of water resource and less effect on the ground water but the surface soil may be affected. As this method is used for the application of fertilizer and the nutrients may be concentrated nearby which has less efficiency use of water resource. It may raise and pollute the ground water and may have an impact on the natural drainage [15].
- b) Water Quality: the reservoir constructed at the farm exposed to evaporation as it is in area with high temperature increases the loss of water. In the reservoir that will be constructed at the farm alkalinity, growth of algae and stagnancy of water, which has an impact on the quality of water. The suspended particles may also lower the life time of the reservoir and have an effect on the computerized drip irrigation system.
- c) Soil and water pollution: Irrigating chemical/fertilizer/ holding water concentrated the nutrients on the soil colloid particles and make it saline or alkaline in extreme extent. There are no resource development activities in the nearby area but a number of irrigation projects with the Tana Lake basin which may compute for the resource. Impact on the project is insignificant because there is other water resource development in the area computed with project.

Fertilizer management

Fertilizer is an inorganic industrial product that provides essential chemical nutrients to the soil for the proper growth and production of plants. Fertilizers have significant contribution in the soil environment by making the plant highly productive; improve soil quality, improving plant physiology. It will have potential negative impact if there is mismanagement and application regarding quality, time and amount [16].

The project is preparing the soil for rose flowers by adding compost (organic fertilizer) in order to increase the fertility of the soil. But the amount of essential nutrients in the compost is not known. So in order to increase productivity with in short period of time the project tends to apply recommended fertilizers such as DAP, UREA, Potash etc. When these synthetic fertilizers are applied they will have negative impact on the environment.

The anticipated impacts of using synthetic fertilizer in this project are as following.

- a) Impact on vegetative cover: Excessive rates of fertilizer application without considering the soil condition, crop/plant situation and/or type and time adversely affect the growth of

planted species. Intensive fertilizer application can also damage soil micro-organisms that have an impact on the vegetation [16].

b) Impacts on the soil: when fertilizers are applied beyond the recommended level they have an effect increasing soil acidity using heavy nitrogen, change and damage the biological and physical property of soil such as structure, aeration and increasing concentration of heavy metals [17].

c) Impacts on human health: while fertilizers cause relatively little harm to wild life at least in comparison to the damage caused by pesticides, they are hazardous in certain circumstances, to human health especially on those who are engaged in the application [18]. These include dust exposure from fertilizer spray and ingesting of nitrate that causes serious health damage and the temperature of the green house will be normal for plant but affects for human being. Tana flora plc apply different fertilizers using fertigation using computerized system that can reduce the effect but during loading, mixing and reacting with soil and water it hinders human health.

d) Impacts on water resources (ground water and surface water): If fertilizers have been applied in more quantity than the required the unused part will be leached down to the ground water or washed to surface water. This may reduce the quality of ground water for drinking and irrigations [19].

Pesticide Management

In addition to the unavoidable environmental condition variability the dynamics of insect pests and epidemic governs the production. Pesticides are chemicals use to destroy or prevent any pests or disease causing organisms to plant or animal and unwanted plants that is weed [16]. Pesticides (which include herbicides, insecticides, fungicides and more) can contaminate organisms, soil, water, turf, and other vegetation. It is estimated that less than 0.1% of the applied pesticide reaches the target pest, leaving 99.9% as a pollutant in the environment, including soil, air, and water and on nearby vegetation. The adverse effect of pesticide use includes degrading water and soil quality, effect on non-targeted lives like soil organisms, aquatic life, human beings, insects, cattle etc, air pollution, an increase of pesticide resistance by targeted pests [19].

Because the cost of these chemicals they were used by large farms. Tana flora is a business company so pesticide will be used for flowers and fruits. Whether pesticides are applied to plants

224 foliage or incorporated into soil a high proportion of pesticides eventually move into the soil.

225 These chemicals then:

- 226 a) may vaporize into atmosphere without any chemical change,
- 227 b) may enter through soil in liquid/solution form and be lost from soil by leaching,
- 228 c) may undergo chemical reactions within /surface of soil or broken down by soil micro-
- 229 organisms and may be absorbed by plants and detoxified within the plants

230 Pesticides affect the environmental components if they are not applied and handled carefully.

231 Impacts on water environment; Pesticides can move from the site of application via drift,
 232 volatilization, leaking, and runoff. Pesticides including herbicides can and do leak to contaminate
 233 ground water. Once ground water is polluted with toxic chemicals, it may take many years, a
 234 huge expense and a complex process for the contamination to be cleaned up [20]. As a result, the
 235 contamination (by pesticides) of ground and surface water, which supplies the greatest part of
 236 drinking water, is a serious problem worldwide [21]. When pesticides contaminate water, they
 237 can be harmful to the fish and other marine or freshwater animals. As water resources are far
 238 from the project area the impact will not be significance in the near future but severe in the long
 239 run unless measures are taken.

240 1.Impacts on human beings: The effects of pesticides on human beings are the following:

- 241 a) Acute effects which appear immediately or very soon after exposure and ingestion of
- 242 chemicals. These are headache, irritability, dizziness, loss of appetite, nausea, muscle
- 243 twitching, convulsion and loss of consciousness [18].
- 244 b) Chronic/long-term effects which may manifest them many years later and whose origins
- 245 are often difficult to trace and these can be carcinogenic effects, neuro-behavioral effect,
- 246 reproductive effects, diabetes and so on [22].

247 The effects of pesticides on human beings who live in the surrounding area are the following:

- 248 a). Because chemical pesticides have residual effects after applied (food residue), especially on
- 249 fruit and vegetable crops, which are directly consumed, the potential health hazard is
- 250 considerable [23].
- 251 b). The surrounding farmers do rear domestic animals which directly graze grass feed and
- 252 depend on water sources near by the farm that can easily be contaminated by pesticide spray.
- 253 This affects the health of animals resulting in poor quality of animal product. As the farmers

also do depend on animal products as source of food contaminated animal products can be source of contamination to human living away from the source of contamination [18].

c) The project is situated near by the road from Bahir Dar to Zegie and a number of by passers are using this highway to walk to the market and other places. Such people may face problems of inhaling contaminated air and suffer from this contamination. The farmers near by the farm may suffer from the frequent applications of pesticides

2. Impacts on soil and biological environment: Chemical pesticides can kill soil microorganisms that influence the soil fertility and structure. Beneficial organisms like honey bee and biological control agents can be killed by the chemical pesticides. Brides those depend on plants flower/fruit and insects around the plants will also directly affect [24]. A number of endemic brides are found around the Tana Lake that can be infected by the spared pesticide in the project.

3. Outbreak of pests and diseases

Frequent application of chemical pesticides can result in emergence of new resistant pest and also shift in pest population. Spread of disease vectors and emergence of a ‘pesticide treadmill [25].

Solid and liquid waste management

Horticulture activities produce different types of waste ranging from liquid to solid, hazardous to non-hazardous, and in effect require safe waste disposal and differentiated treatment. Empty chemical containers and bags (fertilizers, pesticides) and their washing water and obsolete chemicals are the major spheres of concern in addition to which other agricultural waste such as cut off, crop parts and dead, unused soil, and waste water are generated in the sector [26]. In addition damage greenhouse plastics poorly designed and constructed sewage system, human effluents and garbage from office and residence. The impact of such mismanagement of solid and liquid waste has significant effect on the environment. These are

- Pollute the surface and ground water (specially leached down liquid form wastes),
- Disturb the soil environment and soil reaction,
- Lower the aesthetic value of the surrounding and air pollution
- Pest and other harmful organism will be reproduce (such as housefly, mosquito) and transmits disease for human (animal) and plants.

Workers safety and health

Modern agricultural schemes especially horticulture industries are labor intensives. Therefore, the health and safety of the workers should be handled critically as the business will not benefit without their effort. Moreover, as the upcoming projects are new for the prospective employees it is very important to critically anticipate the impacts in this regard and the required management options [27]. The major health and safety impacts that can be anticipated due to this project are:

- Cardiovascular diseases because of inhaling chemicals and pesticides.
- Skin allergy and irritation due to contact with chemicals and pesticides.
- Injuries when using sharp working equipments.
- Spillage of chemicals which may arise from operation materials and equipment yards.
- Risks accident such as fire and explosion.
- STD (Sexually Transmitted Disease) because of the mobility of employees from place to place.

Socio-economic impact

The social benefits of the projects are substantial. It would provide job opportunity to the surrounding community. According to the project management body, during the construction phase 800 people employed as daily and permanent worker. Some small cafeterias and shops start to give services for the project community. As the project starts operation around 1200 people will get job opportunity from the surrounding rural area and Bahir Dar town. The government also pays compensation for the farmers who lost their percales of land for the project. This might have an impact on the farmer's livelihood [28, 29]. In addition to the technology transfer especially, in fruit and vegetable production and skill development will have positive impact on socio-economy of the society.

But it was observed, and discussed with local people the compensation payment rate was not satisfactory and based on the economic value (productivity) of the land. As farmers do not have awareness and knowledge about how to use money properly most of them spent for unproductive means as a result trend of migration, poverty and unemployment have been appeared.

Conclusion and recommendation

The Tana Flora project will have significant contribution to the region as well as to the country in general by producing high quality exportable flowers and fruits. This will have great role in increase the exportable goods and maintain the GDP as well the economy of the country. At a local level it will create job opportunity and diffuse technologies especially in the production of

fruits. However, there are negative impacts on the environment which are expected to happen. There are socio-economic problems, water and air pollution, health problem, disturbs the ecosystem, distortion of aesthetic value due to improper use of chemicals and waste disposal. For these negative impacts it is proposed appropriate mitigation measures and monitoring plan. It can be conclude that the project has manageable negative impacts and more positive impacts. So the project is environmentally suitable/friend as the negative effects take into consideration and the concerned bodies should to take the responsibility in monitoring as they are suggested.

Recommendations

1. The project has to give more emphasis in developing awareness and belongingness by the surrounding people.
2. Compensation given in cash to the displaced households should not be the only remedies to sustain the livelihoods of the households rather should be some training and monitoring to invest their compensation to income generating businesses.
3. The project should substitute the distracted trees during land preparation in a selected site to reduce land degradation.
4. There has to be a possibility to use rain and waste water as alternative source in order to reduce the stress on the Lake Tana.
5. Construct drinking water tank at some distance from the site for the project community.
6. Try to other environmentally friendly options of pest control pest such as biological control, cultural practice etc.
7. The application of pesticides should be strictly following the rules and regulations of registration and application of pesticides by the government of Ethiopia.
8. The concerted effort of various parties involved in research, academics and development is highly needed in order to avoid or minimize and thereby increase role of horticultural crops in food security, income generation and environmental managements [30].
9. The proponent should apply the recommended environmental management plan to reduce the waste from different sources and find suitable mechanism to treated it or area for damping to save the Tana Lake and surroundings.

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