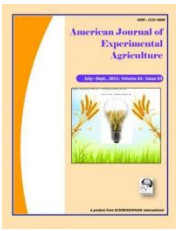

American Journal of Experimental Agriculture
4(1): 90-100, 2014

SCIENCEDOMAIN *international*
www.sciencedomain.org

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

Mushir Ali[1*]

[1]*Department of Geography and Environmental Studies, Mekelle University, Ethiopia.*

Author's contribution

Author MA designed the study, performed the statistical analysis, he wrote the protocol and the draft of the manuscript, managed the analyses of the study; literature searched and approved the final manuscript.

Case Study

Received 16th March 2013
Accepted 28th September 2013
Published 21st October 2013

ABSTRACT

Recently adopted horticultural crops under the policy of diversification of agriculture in Ethiopia will possibly have an impact on bio-physical, social-economic environment. This study was conducted to assess the potential impact of under construction horticultural project, for different crops of horticulture. Impacts were computed on soil and water resources, air quality, flora and fauna, local socio-economic aspects and human health in the peripheries of the Tana Lake, Ethiopia. Environmental quality index and range methods were used for impact assessment. The analysis shows that high level impact may be on soil and water resources, medium level impact on ecosystem and human health and low level of impact on the air quality and socio-economic conditions of surrounding population.

Keywords: *Horticulture; impact; bio-physical environment and society.*

**Corresponding author: Email: mushirspn@rediffmail.com;*

1. INTRODUCTION

During the last decades of 20th century, Ethiopian agriculture stood at a cross-road because the food grains production has become uneconomical by increasing gap between input cost and output price per unit weight of its production by increasing cost of inputs, in successive years under the influence of world economic order [1]. Reduction in the size of operational holdings due to division of holdings among the heirs, drought and soil erosion have also contributed to the reduction of productivity. As a result, the economic viability growing some traditional food crops like food grains has badly affected. This critical agricultural situation called upon a drastic and constructive change in agricultural policies, and object orientation of farmers toward diversification of farming system, i.e., horticulture, floriculture and market based livestock ranching [2,3].

The rapidly increasing demand of flowers, fruits and vegetables in developed countries has made the horticultural produces as preferred exportable commodities. Diverse Ethiopian landforms and unproblematic accessibility to European, Asian and Middle-East markets lead to a huge potential for supply of high quality flowers, fruits and vegetables. In addition, the demand of the fresh and cheap vegetables is increasing year after year at local level due to rising income, purchasing power, population growth, urbanization, health consciousness and improvement in living standard particularly in urban areas [4]. Horticultural produces might be a blessing for Ethiopian land if it is developed properly with an assured, efficient post-harvest transfer improved technology for fruit and vegetable production. Ethiopia has fairly constant tropical climate that favors farming to be continued throughout the entire year. Relative low production costs and wide range of agro-climatic conditions for horticultural cultivation make enable the country to earn a huge amount of foreign exchange through the export of vegetables round the year [5].

The floriculture has recently become an important agricultural sector for Ethiopia regarding the export potential. Since 2001 up to 2007, the export value of flowers has increased from 0.3 million USD to 113 million USD [5] which accounts for 7.8% of the total export. To attract potential foreign investors, many regions have been invested in physical infrastructure to make accessibility for agricultural lands [6]. The Tana horticultural project PLC is one of them those projects intend to engage in flowers, fruits and vegetables production. Although such types of project have been considered helpful to enhance GDP, creating employment opportunities, and earning foreign currency earning [7], they may have impact on the environment [8]. Therefore, study was conducted to assess environmental impact of the Tana horticultural project.

Environmental impact assessment (EIA) is a process used to forecast and judge both positive and negative bio-physical and social impacts of the proposed development project [9]. Thus, Environmental impact assessment can be defined:*"…an activity designed to identify and predict the impact on the bio-geophysical environment and on man's health and well-being of legislative proposals, policies, programs, projects and operational procedures, and to interpret and communicate information about the impacts"* -Munn 1975 [10].

2. OBJECTIVES, APPROACHES AND METHODS OF THE STUDY

2.1 Objectives

The present work was conducted to assess environmental and social impacts of the under construction flower, fruits and vegetable project with following objectives.

- To assess impact of the project on soil, water resources, air quality and ecosystem, and
- To describe effect on the socio-economic and health conditions of the people at surrounding areas.

2.2 Approaches and Methods

This environmental impact assessment study was conducted in two phases; the first phase was started by reviewing of relevant documents of EIA guidelines, the environmental policies and the laws of Ethiopia. Second phase contains of the available and relevant information that was collected from under construction project through prepared checklists, visual observations regarding impact on the bio-physical and socio-economic conditions of surrounding spaces. To prepare checklists, the previous studies of Canter [9], Bisset [11], Maclearn [12], Lawrence [13], Morgan [14] and EPLUA [15] were reviewed. Moreover, three rounds of the focus group discussions were made with project manager, construction workers, and on farm workers. To assign weight for impacts on the given 0-1 scale, each attribute of soil, water, air, ecosystem and socio-economic (see Table1), was well discussed related to experts of agriculture, soil and water resources, environmental sciences, botany and wildlife, political science, geography and health who belonged to Amhara Regional Agriculture and Rural Development Bureau, Amhara Bureau of Investment and Bahirdar University to recognize possible impacts on soil and water resources, air quality, flora and fauna, aspects of local economy, society and human health.

The scale 0-1having 10 points was applied logically based on the review of the previous studies, comparative and relative importance of each parameter to assign weight for every environmental attribute. To assess environment impact assessment, the environmental quality assessment index was used. Moreover, range method was applied to ascertain the significance impact as high, medium and low for different attributes of environment. To get detail about effect on the socio-economic conditions, randomly 30 villagers were selected from the surrounding rural spaces of the project.

2.3 Base Line Information about the Project Site Environment

The Tana flora intends to produce rose cut flowers, fruits (mango) and vegetables for export and domestic market. The project covers total 124 ha land that has been allocated to grow rose (40 ha), fruits (30 ha), vegetables (25 ha), wind break trees (7.5 ha), green house to produce flower and selected variety of mangoes (20 ha), and to build office and residence for workers (2 ha) respectively.

The project is located about 17 km from Bahirdarcity and 2.7 km from the Tana Lake at Wanjeta *Kebele* (block) in Bahirdar Zuria district of Amhara regional state, Ethiopia. It covers a land of gentle slope ($0\text{-}3^0$) constituted by volcanic rocks. The soils are thick composed, deep and reddish lateritic with PH 5.5-6.7. Aswampy area lies at the Tana Lake side which recharges the ground water. Existed rocks work as barrier for unprecedented overflow of the lake. The area receives an annual rainfall of 1463mm. The mean monthly maximum and minimum temperature ranges from $23\text{-}33.5^0$C and $6.3\text{-}16.7^0$C respectively. The *Kebele* has a total area of more than 7000 ha covered by crops, grazing land, settlements and forest/bushes. The economy of the area is subsistence type mainly based on agriculture,

livestock husbandry and fishery where major farmed food grains are millet, maize and oilseeds.

3. RESULTS AND DISCUSSIONS

3.1 Environmental Impact of the Project

Environmental impacts belong to mainly during construction and operation phases of the project, the following issues (Table1) were identified and analyzed to assess the environmental impact of the activities of the proposed project using environmental quality assessment index. Similarly, methods had been used by Canter [9], Bisset [11], Maclearn [12], Lawrence [13], and Morgan [14].

(1) Environmental quality assessment index

$$EQAI = \sum_{i=1}^{n} AiWi$$

Where,

EQAI = Environmental Quality Assessment Index
Ai = Number of environmental attributes
Wi = Weight of the particular attributes

(2) Range method, that was used for significance level of impact assessment

$$LIA = \frac{Hvi - Lvi}{ci}$$

Where,

LIA= Level of Impact Assessment
Hvi = Highest value of impact assessment
Lvi = Lowest value of impact assessment
Ci= number of significance classes

Table 1. Checklist for impact of the project activities on the quality of environment

Method to assign weight for each attribute	Parameters	Impact level	$\sum_{i=1}^{n} AiWi$	
Soil Resources related different issues were discussed the soil scientists, and professor of soil department, Bahir Dar university to assign weight at the10 points scale 0-1.	1. Soil Erosion during land preparation	0.7 ±		
	2. Nutrient loss during land preparation by water	0.9 ±		
	3.Use of fertilizer, pesticides and machineries may result in soil physical and chemical disturbance	0.7 ±		
	4. Soil salinity, alkinity and solidicity	0.6 ±		
	5. Imbalance biological activities as a result of contamination of soil with toxic chemicals and loss of organic nutrients	0.7±	=0.72	High
Water Resources regarding impact on water resources, concerned experts of water resources office and professor of water resources department, Bahir Dar university were	1. Flooding, channel modification, siltation.	0.6±		
	2. Reduction/lowering of surface or ground water table.	0.6±		High
	3. Soil water logging results from mismanagement of water	0.8±		
	4. Excess increment of nutrients in	0.8±		

Method to assign weight for each attribute	Parameters	Impact level	$\sum_{i=1}^{n} AiWi$	
interviewed to provide weight for different attributes at the given scale 0-1.	water bodies (eutrophication). 5. Pollution of surface and ground water through direct or indirect addition of toxic chemicals, waste, organic chemicals	0.8±	= 0.7	
	6. Resource competition (if there are no water resources development activities).	0.6±		
Air Pollution effects on quality of air were discussed experts of environmental chemistry and health professionals to decide weights for the attributes at 0-1 scale	1.Emission of gases like ammonia, methane etc to the atmosphere for warming atmosphere	0.7±		
	2. Reduction of air quality; endangering of life (flora, fauna).	0.6±		
	3.Depletion of ozone layer & climatic change due to emission of gases (SO_2, CO_2, NO_2, CO, CFCs) to the atmosphere	0.5±	=0.6	Low
	4. Affecting distribution of settlements.	0.6±		
Ecosystem (Flora & Fauna) Concerned weight for attributes related to impact on the ecosystem. Environmental scientists, subject expert of botany, wild life and biogeography were interviewed to assign weight at 0-1 scale.	1. Contamination or use of polluted water may affect wildlife and nearby communities to the project area.	0.5±		
	2. Introduction of new species or change of cultivation may cause for development of pests, diseases or weeds.	0.8±		
	3. Direct/indirect killing of aquatic and terrestrial animals Spreading of pesticide/insecticide for different purposes.	0.8±	=0.65	Medium
	4. Loss of flora and fauna can be occurred when projects are established at the spot or in vicinity.	0.5±		
Socio-economics Social geographer, political scientists were interviewed to provide at 0-1 scale. According to importance of each affected attribute in each socio-economic order, weights were decided accordingly.	1. Land use and tenure conflict may occur around the project	0.6±		
	2.Inundation of farmlands like loss of agricultural, forest or community grazing land by waste generated from the project	0.6±		
	3. People may expose to further social and economic crises when their farm land is occupied by project	0.6±		
	4. Conflict due to lack of awareness about the project	0.7±	=0.62	Low
	5. Impact on culture due to immigrants and additional pressure on the	0.6±		

Method to assign weight for each attribute	Parameters	Impact level	$\sum_{i=1}^{n} AiWi$	
	services, i.e., health, dwelling, transportation.			
Human Health Effects on Human health were discussed experts of environmental studies, physicians, medical consultants to decide the weights for attributes related to effect on human health by many ways at the given scale 0-1.	1.Transmission of disease between human and from plants/animals to humans	0.4±		
	2. Emission of toxic gases, vapors, dust, emission of toxic liquid and their cumulative effects badly affect human health inside and around outside of the project	0.7±		
	3.Occupational effects on health of workers due to fugitive dust, material usage, noise and mechanical/chemical contact	0.7±	=0.66	Medium
	4. Death and injuries to human beings due to improper loading-unloading, storing and disposing of chemicals.	0.7±		
	5. Inhaling polluted air inside/around outside of the project.	0.8±		

Table 2. Significance Level of Environmental Impact Assessment

Assessment level $LIA = \frac{Hvi - Lvi}{ci}$	Significance Level	Environmental attributes
±.068-0.72	High	Soil resources and water resources
±0.64-0.68	Medium	Ecosystem and human health
±0.6-0.64	Low	Air quality and socio-economics

3.1.1 High impact on soil and water resources

The expected impacts on soils are associated with removing trees, shrubs, and grasses during land preparation for project activities will break the natural compactness of soils and holding capacity of water result loss of soil texture. Moreover, due to erratic nature of rainfall in study area that may accelerate soil erosion and loss of nutrients. Use of fertilizer, pesticides and continuous irrigation for horticultural production in the project, situated in high radiation exposure zone may disturb the electrical conductivity of soils. As result salinity, alkinity and solidicity may occur in the soils that lead to negative impacts on fertility of soils [16, 17].

Depletion of water resources: At the time of land preparation, in the study site natural channel to drain water in rainy season has been modified which can enhance the siltation. The project will run with irrigation system for the cut flowers and the fruits require high

efficiency use of water resource, can effect on the ground water [18]. Application of fertilizers, the nutrients may be concentrated nearby roots of the plants. Directly or indirectly they may pollute the ground water as well as through runoff it may reach in the down streams in which these nutrients can increase eutrophication in the water [19,20].

Recommendations:

i. The project should have reclamation activities to replace the natural vegetation affected during land preparation to save land degradation at the selected site. The natural compactness of the soil that has been disturbed during preparation of the project. The traditional soil bunds and cut off drains methods should be adopted to check soil texture and fertility [21].
ii. To enhance the cultural practices for maintaining soil nutrition and pest control, i.e.,the drainage ditches methods, leaving fiber crop residues and crop rotation traditional techniques should be adopted. At least once in a year, soil should be tested to get update regarding chemical properties of the soil at the project site and its peripheries.
iii. The local cactus, mangrove species should be planted along the drain of the project to absorb the abnormality by excess increment of nutrients and toxic contamination by natural way to save underground water, nearby water bodies and the aquatic ecosystem. Moreover, to check contamination in water bodies, the rules and regulations by the government of Ethiopia for the application of pesticides and fertilizers should be strictly followed [15].

3.1.2 Medium impact on ecosystem and human health

To get benefit from the diffusion of horticultural crops production, it is necessary to control or save crops from the pests, bacteria, weeds and diseases with the use of biocides. However, if they are not applied and handled carefully can have adverse effect on non-targeted lives like soil organisms, aquatic life, human beings, insects, animals, air quality, and can increase of anti-biocides resistance in pests and bacterias [22]. Such types of conditions may be more harmful when these chemicals enter through soil in liquid/solution form and micro-organisms of soil absorbed through plants and detoxified within the plants those can affect the consumers' chain (plants, animals, micro-organisms) of the ecosystem in vicinity of the project. Besides, chemical pesticides can kill soil microorganisms those influence the fertility and chemistry of the soils [23]. Beneficial organisms like honey bee and biological controller agents can be killed by the biocides. The dependent insects, on the plants, flowers, and fruits will be affected directly [24]. As a number of endemic birds are found around the Tana Lake those may be infected by spreading of biocides in the project. Besides, biocides can contaminate water bodies by surface runoff releasing polluted water that will injurious to the fish and other marines. Groundwater, major source of drinking water may be contaminated by percolation of toxic substances that containing agreat part supply of drinking water in the vicinity of the project.

Impacts on human health: use of fertilizers and biocides may be hazardous in certain circumstances, to human health, especially those who are engaged in their applications [25]. These include dust exposure, fertilizer spray and ingesting of nitrate that may causes for serious health damage in two ways; firstly, immediate effects by ingestion of chemicals may create headache, irritability, dizziness, loss of appetite, nausea, muscle twitching, convulsion and loss of consciousness. Secondly, chronic effects can be as carcinogenic, neuro-behavioral, reproductive, diabetes and so on [26, 27].

Recommendations:

i. To minimize the negative effects of pesticides and the fertilizers, their brands those were certified by Environmental protection land administration and land use authority of Ethiopia particularly for surroundings of the Tana Lake should be used. Moreover, the project employees should be trained properly to avoid inappropriate and over doses of pesticides and fertilizers.
ii. Since, population at the project site and its surroundings uses drinking water from the underground so drinking water tank should be constructed at some distance from the site. The quarterly lab tests of the water must be conducted to avoid any transitory and chronic disorders among the people who engaged in the project and living at surrounding spaces.
iii. The periodic investigations related to community heath should be conducted jointly by the project authority and the civil health administration. Besides, awareness should be developed among the project workers and people of the study area through orientation programs regarding the injurious effects of the contaminated water and pesticides on the health, and to save from epidemics as well as HIV-AIDS.

3.1.3 Low impact on socio-economics and air pollution

The social benefits of the projects would be substantial by providing job opportunities to the surrounding community. According to the project management, during the construction phase 120 permanent workers and nearly 700 people had been employed as daily wagers. Some small cafeterias and shops have started to give services for the workers. As the project would be operated properly then the management will generate additional job opportunities about 400 people of the surrounding spaces.

The government has already paid a compensation for the farmers who lost their lands. This might have an impact on the farmer's livelihood [28]. However, it was found by the interviews of the farmers during field survey that the paid compensation was neither satisfactory nor based on the true value of the land. Moreover, some farmers who got the compensation were unaware how to utilize the money properly, most of them spent it for unproductive means. As a result, migration, poverty, and unemployment were commonly reported by villagers. The loss of land for grazing for livestock, and accumulation of the project waste were other common problems. However, arrival of workers from outside of the study area create additional pressure on the services; transportation, health and dwellings. Moreover, the engaged workers coming far away from the home may contribute to so social mal-adjustments those may appear in forms of prostitution, crime and so on in the adjacent areas of the project.

Preparation lands for the plantation of the different horticultural crops, and during their cultivation, there will use chemicals fertilizers and chemicals in many ways, as results the air particularly in green houses will pollute. Mixing of contaminated air in the surroundings sphere of the project in long term may injurious to the indigenous flora and fauna [28]. Accumulation of waste will create sting smell in the air may be cause to avoid built up residences, and may be cause to vacate the surrounding spaces of the project, and down ward side of wind direction [29].

Recommendations:

i. To the displaced households, compensation in cash is not be the only remedies for sustaining their livelihoods, so guidance should be provided to invest the compensation money in income generating businesses such processing food items, their marketing as well as to open cafeterias those are required in Bahirdar city and its peripheries.
ii. The concerted efforts of various parties those involved in research, academics and development, are highly needed in order to avoid or minimize the negative impacts, and thereby increase role of horticultural crops in food security, income generation and environmental management [30]. Their suggestions regarding to reduce the waste from the different sources of the project and to find suitable mechanism for treatment of the dumping waste to save the Tana Lake and its surroundings, should be adopted and implemented.

4. CONCLUSION

The Tana Flora project will play role in the significant contribution to the region by producing high quality exportable flowers and fruits. It will likely enhance the exportable goods and maintain GDP of the country. At local level, it may provide job opportunities and will also be helpful by diffusing of technologies, especially for flowers and fruits production. The interaction of people from different regions can create motivation surrounding population to produce the horticulture to get quick cash for their economic viability. However, negative impacts on the environment are also expected. It was calculated that the possible high level of impact (±.068-0.72) would be on soil and water resources. Moreover, the environmental quality index value (±0.64-0.68) reflects to medium level on the ecosystem and human health. The impact will be low on the socio-economic and air pollution.

To minimize the negative environmental impacts of the horticultural project, some mitigation measures are suggested; to adopt traditional methods and cultural practices for maintaining soil nutrition, and pest control, to plant local cactus, mangrove species to save underground water, nearby water bodies and the aquatic ecosystem, and to aware the project workers and people of the study area regarding the injurious effects of the contaminated water and pesticides on the health, and to save from epidemics.

ACKNOWLEDGEMENTS

I am thankful tomy post graduate students, Getnet Sintayehu, Mulugeta S/Leab, Zenawi Kiflay, and the manager & the head of Tana Flora, Amhara National Regional State Environmental Protection Land Administration and Use Authority, the different subject expert of Bahir Dar university and related offices to provide assistance in many ways.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. IAASTD. Agriculture at a crossroads, international assessment of agricultural knowledge. Science and Technology for Development. Washington DC: Island Press; 2009.
2. FAO. Enhancing crop-livestock systems in conservation agriculture for sustainable production intensification: a farmer discovery process going to scale in Burkina Faso. Integrated Crop Management 7. Rome: Food and Agriculture Organization; 2009.
3. Benerji A. Challenges faced in communication by rural marketers in India. Kuruksh: A Jour of Rur Dev. 2005;53(7):6-7.
4. Ali M, Neka M. Livestock husbandry and economic-sustainability of small farmers in peri-urban areas. Ethio Jour of Env Stud and Mang. 2012;5(2):207-17
5. Pretty J, Toulmin C, Williams S. Sustainable intensification in African agriculture. Int Jour of AgriSus. 2010;9(1):5-24
6. Joosten F. Development strategy for the export orientated horticulture in Ethiopia. Unpublished thesis. University of Wageningen; 2007.
7. Getnet D. Report on the regulations, legal conditions and incentives for foreign direct investment in Ethiopia. Fact sheet for the final report; 2009.
8. Wathren P. Environmental impact assessment: theory and practice. London: Rutledge. 1995;47-53
9. Canter LW. Methods for environmental impact assessment: theory and application (emphasis in weighing scale and checklists). PADC, EIA and planning unit (ed.) Environmental Impact Assessment, MartinusNijhoff, The Hague; 1983:165-233
10. Munn, RE. Environmental impact assessment: principle and procedures. New York: John Wiley and sons; 1975.
11. Bisset, R. Methods for environment impact analysis: recent trends and future prospects. Jour of EnvManag. 1980;11:27-43.
12. Maclaren VW. Multi-criteria evaluation methods. In: Maclaren VW, Whitney JBR, editors. New directions in environmental impact assessment in Canada. Toronto: Mathuen. 1998;221-45.
13. Lawrence DP. Cumulative effects assessment at the project level. Impact Assessment. 1994;12:253-273
14. Morgan RK. Environmental impact assessment: methodological perspective. the Netherlands: Kluwer Academic; 1998.
15. EPLUA. Environmental protection land administration and use authority of Ethiopia: Addis Ababa
16. Millennium Ecosystem Assessment. Ecosystems and well-being. Washington DC: Island Press; 2005.
17. Smith P. Soil organic carbon dynamics and land use. In: Braimoh AK, Vlek PLG, editors. Land use and soil resources. Netherlands: Springer; 2008.
18. Gotvajn AZ, Zagorc KJ, Tisler T. Estimation of environmental impact of some of the most often occurring pesticides in Slovenian surface and underground water. Water Sci Technol. 2001;44(7):87-90.
19. National Research Council. Impact of genetically engineered crops on farm sustainability in the United States: committee on the impact of biotechnology on farm-level. . Washington DC: The National academies press; 2010.
20. Pimentel D. Green revolution agriculture and chemical hazards. Sci Total Env. Sep. 1996;188:86-98.

21. Ali M, Kendru S. Soil and water conservation management through indigenous and traditional practices in Ethiopia: A case study. Ethio Jour of Env Studies and Mang. 2012;5(4):343-55.
22. Aktar MW, Sengupta D, Chowdhury A. Impact of pesticides use in agriculture: their benefits and hazards. Interdiscip Toxicol. March. 2009;2(1):1-12.
23. Ruggieri FD, Archivio AA, Fanelli M, Mazzeo P, Paoletti E. A multi-limiter investigation on the mobility and persistence of pesticides in the loam soil of the Fucino Plain (Italy).Jour Env Mon. Jun 2008;10 (6):747-52.
24. Khan Z, Midega C, Pittchar J, Pickett J, Bruce T. Push-pull technology: a conservation agriculture approach for integrated management of insect pests, weeds and soil health in Africa. Int Jour of Agri Sus. 2011;9(1):162–170.
25. Pingali PL, Roger PA. Impact of pesticides on farmers' health and the rice environment. Kluwer, Dordrecht; 1995.
26. Plestina R, Mercier M. Human health and environmental hazards arising from the use of chemicals in developing countries. Sci Total Env. Sep. 1996;188:135-40.
27. Koh D, Jeyaratnam J. Pesticides hazards in developing countries.Sci Total Env. Sep 1996;188:78-85
28. Woolcock M. Social capital and economic development: towards a theoretical synthesis and policy framework. Theo and Soci. 1998;27:151–208.
29. Dudley N, Stolton S. Air pollution and biodiversity: a review. Bristol: Montpelier; 1996.
30. Kampa M, Castanas E. Human health effects of air pollution, Env Pol. 2008;151:362-67

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=272&id=2&aid=2320