Trakia Journal of Sciences, No3, pp 343-347, 2013

Available online at:
http://www.uni-sz.bg

ISSN 1313-7069 (print)
ISSN 1313-3551 (online)

Original Contribution

ENERGY INPUTS AND CLIMATE CHANGE: A CASE STUDY OFVEGETABLE PRODUCTION UNDER *FADAMA* IN NORTH CENTRAL NIGERIA

H. Y. Ibrahim*, H. I. Ibrahim

Department of Agricultural Economics and Extension, Nasarawa State University, Keffi, Nigeria

ABSTRACT
The study examined the energy use for vegetable production under *Fadama* in north central Nigeria with a view to assess the likelihood of the production system contributing to climate change. The data for the production of two major vegetables produced under *Fadama* (Onion, and Tomato) were collected from 200 *Fadama* farmers using a questionnaire. The results show that Tomato production was the most energy intensive among the two vegetables investigated. For all the vegetables, the usage of non-renewable energy inputs especially fossil fuels such as petrol and urea fertilizer was quite substantial and accounted for about 41.71 and 40.62% respectively of the total energy inputs used for vegetable production. The energy use efficiency and energy productivity was very low. The energy use efficiency was, 0.20 and 0.10 while the energy productivity was 0.25 and 0.12 for Onion and Tomato respectively. The study concluded that the *Fadama* production system contributes to global carbon emission which in the long run leads to climate change. The study recommends the development of fuel efficient water pumps for irrigating *Fadama* lands.

Keywords: carbon emission, non-renewable energy, fossil fuels, tomato, onion

INTRODUCTION

Agriculture and food systems play an important role in fossil fuel consumption and climate change because of their significant energy use and because of agriculture's potential to serve as a sink for the negative externalities of energy use and a source for renewable energy (1). In all societies, limited supply of arable land and desire for an increasing standard of living have encouraged an increase in energy inputs to maximise, yields, minimise labour-intensive practices, or both (2).This is obviously the situation in delicate production system such as the *Fadama* production systems in north central Nigeria. *Fadama* is the Hausa word used for describing wet lands or the seasonally flooded or floodable plains along major Savannah rivers and/or depressions on the adjacent low terraces (3). These lands are under pressure due to the competing land uses to which they are put, conflict among different users, mounting demographic pressures as well the complicated tenural arrangements obtainable in *Fadama* communities. Hence, the only means of raising agricultural output is through the intensification of energy inputs usage which may not be sustainable in the long run. *Fadama* lands are no longer allowed to replenish nutrients used up after a period of cropping, leading to decline in fertility of the land and reduction in crop yield (4). This scenario makes the energy inputs - *Fadama* agriculture relationship to become more and more important, thus, the need for a study on energy analysis in vegetable production under *Fadama* in order to evaluate the efficiency and environmental impacts of *Fadama* production systems.The production of vegetables under *Fadama* is an important component of the

***Correspondence to**:*H .Y. Ibrahim, Department of Agricultural Economics and Extension, Nasarawa State University, Keffi, Nigeria, E-mail: hussein464@yahoo.com*

farming systems in northern Nigeria where irrigation is practiced. This is because; it is a very lucrative economic activity due to the availability of markets in the vicinity of the production areas and in the southern Nigeria where there is high demand for them (5). The major vegetables produced extensively under *Fadama* are Tomato and Onion. To meet the growing demand of the increasing population and for exports, the productivity of agricultural inputs would require better management of food production systems. Therefore, the assessment of energy inputs usage for vegetable production under *Fadama* is required to understand the current situation for improved use of energy resources and for future steps to be taken in order to improve vegetable production under *Fadama* and to safe guard the environment.

MATERIALS AND METHODS

The study was conducted in Kaduna state which is located in the Northern Guinea Savanna zone of Nigeria. According to (6), it lies by the southern end of the High Plain of Nigeria, bounded by parallel $9^0$03'N and $11^0$32'N, and extends from the upper River Mariga on 6^o05'E to 8^o48'E on the foot slopes of the scarp of Jos Plateau. In the *Fadama*, the dark grey clay soils (vertisols) have come highly valued and are focused on for intensive agricultural activities especially during the dry season. Large areas of such *Fadamas* are used for economically valuable market gardening for growing tomatoes, chillies, sweet pepper, okra, onion, Irish potato and sugar cane using tradition "shadulf" irrigation (in the flood-plain\Fadama of Galma and Tubo basins).

Sampling technique

The population for the study comprised the dry season vegetable farmers that cultivate Tomato, and Onion under *Fadama* in Kaduna state. Purposive sampling was used to select seven local government areas (LGAs) noted for intensive production of vegetables in Kaduna state. Furthermore, from the seven LGAs, four LGAs were randomly sampled for the study. Finally, the lists of registered *Fadama* farmers in the four LGAs, was used to randomly sample 25 Tomato and 25 Onion farmers from each LGA to give a total of 50 respondents per LGA and 200 farmers for the study. Primary data were collected with the aid of a questionnaire administered by trained enumerators. The data collected covered farmers socio-economic variables, inputs as well as output data.

Data analysis

The data collected were analyzed using descriptive statistics.The energy equivalents of inputs used and output obtained in vegetable production are illustrated in Table 1. The data on energy use have been taken from a number of sources, as indicated in the table. Based on the energy equivalents of the inputs and output **(Table1)**, the energy ratio (energy use efficiency) and energy productivity were calculated by using the equations 1 and 2 (7) and (8), in addition to describing the pattern of energy use for vegetable production under the *Fadama* production system.

$$\text{Energy use efficiency} = \frac{\text{Energy output (MJ}^{-1}\text{)}}{\text{Energy input (MJ}^{-1}\text{)}} \quad ......\ 1$$

$$\text{Energy productivity} = \frac{\text{Vegetable output (kg ha}^{-1}\text{)}}{\text{Energy input (MJ}^{-1}\text{)}} \quad ....2$$

Table 1. *Energy equivalents of inputs and output in vegetable production under Fadama*

Input (Unit)	**Energy equivalent, (MJ unit−1)**	**Source**
Labour (Man hrs)	02.30	(9)
NPK fertilizer (kg)	11.76*	
Urea fertilizer (Kg)	66.14	(10)
Chemical (Litres)	101.20	(9)
Seed (kg)	1.00	(11)
Water (Litres)	0.63	(9)
Petrol (Litres)	42.30	(11)
Yield (Kg)	0.80	(12)

*Explanation is provided below.

The NPK 15:15:15 brand of compound fertilizer is widely used in the study area. The fertilizer blend contains Nitrogen, Phosphorus and Potassium combined in a ratio of 15:15:15 packaged in a 50kg bag. This implies that a 50kg bag of NPK 15:15:15 fertilizer contains 7.5kg of each of the elements N, P and K. According to (13) the energy equivalent of a unit (kg) of elemental N, P and K are 60.60MJ, 11.10MJ and 6.70MJ respectively. Hence, the total energy equivalent of NPK 15:15:15 in a 50 kg bag was 588MJ.This is equivalent to 11.76MJ per kg of the fertilizer.

RESULTS

Socio economic characteristics of *Fadama* farmers

The average age of the *Fadama* farmers was 39 years and F*adama* farming in the study area is a male dominated economic activity. However, a few female respondents (19.27%) were observed. The membership of cooperatives is a common practice among *Fadama* farmers in the study area. The average household size for a *Fadama* farm was 8 people. Some *Fadama* farmers have households of up to 18 people. Majority of the *Fadama* farmers could comprehend extension guides written in the Hausa language which is spoken in the study area. *Fadama* lands in the study area are mostly acquired through inheritance. The average size of a *Fadama* plot in the study was 0.74 ha. However, the predominant range observed was between 0.51 - 0.75 ha. Both surface and underground water sources are used for irrigating *Fadama* lands. The underground water from open well, tube wells and wash bores are often used as backups when the surface water from streams and rivers or earth dams dries up.

Energy use in Onion production under *Fadama*

The inputs used in Onion production and their energy equivalents, output energy equivalent and energy ratio are illustrated in **Table 2**. About 1.35 litres of pest and disease control chemicals, 95kg of NPK and 65kg of Nitrogen or Urea fertilizer were used in Onion production on a hectare basis under *Fadama*. The use of irrigation water and Petrol were 633.3 and 175 litres respectively. The total energy equivalent of inputs was calculated as 14106.25 MJ Per ha. Petrol had the highest share, of 52.47%, followed by nitrogen fertilizer (30.50%), NPK fertilizer (8.00%) and human labour (5.33%), respectively. The energy inputs of seeds and pest and disease control chemicals were very low relative to the other inputs used in production. The average yield of Onion was about 3616 kg ha−1 and its energy equivalent was calculated to be 2892.8 MJ. Based on these values, the energy efficiency for the production of Onion under *Fadama* was 0.20, while the energy productivity was calculated as 0.25.

Table 2. *Energy inputs, outputs in Onion production under Fadama*

Inputs (Units)	Quantity/ha	Total energyequivalents MJ	%
Labour (Man hrs)	327.00	752.10	5.33
NPK fertilizer (kg)	95.00	1117.20	8.00
Urea fertilizer (Kg)	65.00	4299.10	**30.50**
Chemical (Litres)	1.35	136.62	0.97
Seed (kg)	0.01	1.40E-02	9.92E-05
Water (Litres)	633.20	398.92	2.82
Petrol (Litres)	175.00	7402.50	**52.47**
Total energy inputs		**14106.25**	**100.00**
Yield (Kg)	3616.00	2892.80	
Energy Output–Input Ratio		0.20	
Energy productivity		0.25	

Energy use in Tomato production under *Fadama*

The inputs used in the Tomato production and their energy equivalents, as well as the energy equivalent of the yield were presented in **Table 3.** As indicated in the table, about 1.8 litres of chemicals, 192 kg of NPK and 175 kg of Nitrogen or Urea fertilizer were used in Tomato production on a hectare basis under *Fadama.* The use of human power was about 385 Man hrs. The quantity of petrol used was 167 litres. Average Tomato yield was 2625 kg ha−1and this is equivalent to 2122.4 MJ of energy. The total energy input was calculated as 22833.582 MJ ha−1. Urea fertilizer was the dominant energy input with a share of 50.70% of the total energy inputs. This was followed by petrol (30.94%), NPK fertilizer (9.89%). Based on these values the energy efficiency for Tomato production under *Fadama* was 0.10, while the energy productivity was calculated as 0.12.

Table 3. *Energy inputs, outputs in Tomato production under Fadama*

Inputs (Units)	**Quantity/ha**	**Total energyequivalents MJ**	**%**
Labour(Man hrs)	385.00	885.50	3.88
NPK fertilizer(Kg)	192.00	2257.92	9.89
Urea fertilizer(Kg)	175.00	11574.50	**50.70**
Chemical (Litres)	1.80	182.16	0.80
Seed (kg)	2.10E-03	2.10E-03	9.20E-06
Water (Litres)	1380.00	869.40	3.80
Petrol (Litres)	167.00	7064.10	**30.94**
Total energy inputs		**22833.58**	**100.00**
Yield (Kg)	2653.00	2122.40	
Energy Output–Input Ratio		0.10	
Energy productivity		0.12	

DISCUSSION

Among the two vegetables investigated, Onion had the highest energy output–input ratio. The lowest ratio was for hot pepper. The higher energy output–input ratio for Onion production indicated a higher yield per hectare from the other crops. The energy efficiency ratios obtained for the vegetables are quite low compared to the 1.26 and 0.99 obtained by (14) for green house tomato green house pepper respectively. Tomato production was the most energy intensive among the two vegetables investigated. A total of 22833.58MJ ha^{-1} of energy was used Tomato production while Onion production consumed about 18597.14MJha^{-1} of energy.

The use of inputs in vegetable production under *Fadama* isnot accompanied with the expected yield increase. This is obvious from the values of energy productivity obtained for the vegetables studied. On the average, Petrol and Urea fertilizer accounted for 41.71 and 40.62% respectively of the total energy inputs used for vegetable production. This was due to the fact that the petrol engine water pump is the only device used for irrigating *Fadama* lands.The second most important input was Urea or Nitrogen fertilizer. According to (15), the utilisation of fossil fuel energy in the manufacturing of synthetic inputs such as pesticides and fertilizers, contributes the most greenhouse gas equivalents in cropping operations and is the second largest greenhouse gas contributor besides methane emissions from animals on livestock farms.

For all the vegetables, the usage of non-renewable energy inputs especially petrol and urea fertilizer was quite substantial. This implies that, directly or indirectly, vegetable production under *Fadama*in the study area depends heavily on fossil fuel which, obviously contributes to the process of global carbon emission. Furthermore, currently in the *Fadama* communities, there is no system in place to manage, monitor or reduce carbon emission. In the long run, this may inevitably lead to environmental problems such as global warming and climate change.

CONCLUSION

The production of vegetables in the research area is highly dependent on non-renewable energy inputs which may not be sustainable in the long run. The energy use efficiency and energy productivity for vegetables in the research area were very low. However, to reduce the tendency of the *Fadama* production system to increasingly contribute to global carbon emission and to enhance the sustainability of the production system, the usage of renewable energy inputs especially organic manure should be promoted among *Fadama* farmers. In addition, the study recommends the development of fuel efficient water pumps for irrigating *Fadama* lands. Finally a system for measuring carbon emission should be put in place in the *Fadama* communities.

REFERENCES

1. Ziesemer, J. Energy use in organic food systems. Natural Resources Management and Environment Department Food and Agriculture Organization of the United Nations, 2007.
2. Esengun, K., Gunduz, O. and Erdal, G. Input-output energy analysis in dry apricot production of Turkey. *Energy Conversion and Management;* 48(2):592-598, 2007.
3. Kolawole, A and Scones, I. Fadama land use and sustainability in northern Nigeria: Strategies for the sustainable use of Fadama lands in northern Nigeria. CSER/ABU Zaria and IIED .London p.29, 1994.
4. Ibrahim, H.Y. Sustainability of vegetable production under Fadama in Kaduna state, Nigeria. Unpublished Ph.D. Thesis University of Ilorin, Ilorin, Nigeria, 2009.
5. Alamu , J.F. Marketing of *Fadama* Produced Tomato , Pepper and Onion: A Case Study of Kano and Jigawa State of Nigeria. Unpublished Ph.D Thesis Department of Agricultural Economics and Extension ABU Zaria, Nigeria, 1996.
6. Bello, A.L. Survey of Kaduna State. In Nigeria, A people united a future assured Vol 2:249-254 A.B. Mamman, J.O. Oyebanji and S.W.Petters (eds) Federal Ministry of Information: Abuja, 2000.
7. Mandal, K.G., Saha, K.P., Ghosh, P.K., Hati, K.M. and Bandyopadhyay, K.K. Bioenergy and economic analysis of soybean based crop production systems in central India. *Biomass & Bioenergy*; 23(5):337-345, 2002.
8. Singh, M.K., Pal, S.K., Thakur, R. and Verma, U.N. Energy input–output relationship of cropping systems. *Indian J. Agric. Sci.* 67(6):262–266, 1997.
9. Yaldiz, O., Ozturk, H.H., Zeren, Y. and Bascetincelik, A. Energy usage in production of field crops in Turkey. 5. International Congress on Mechanization and Energy in Agriculture, İzmir, Turkey, pp. 527–36, 1993.
10. Shrestha,D.S. Energy use efficiency indicator for agriculture,.http://www.usaskca/agriculture/caedac/PDF/mcrae.PDF, 1998. Retrieved 12/09/2010, 2010
11. Hatirli S. A., B. Ozkan and C. Fert. Energy inputs and crop yield relationships in greenhouse tomato production. *Renewable Energy*; 31:427-438, 2006.
12. Singh, J.M. On Farm Energy Use Pattern in Different Cropping Systems in Haryana, India. M. Sc. thesis, International Institute of Management University of Flensburg, Germany, 2002
13. Singh, H., Mishra, D. and Nahar, N.M. Energy use pattern in production agriculture of a typical village in Arid Zone India-Part I. *Energy Conversion and Management*; 43(16):2275-2286, 2002.
14. Ozkan, B., Akcaoz, H. and Fert, C. Energy input output analysis in Turkish agriculture. *Renewable Energy*; 29(1):39-51, 2004.
15. Wightman, J. S. “Production and Mitigation of Greenhouse Gases in Agriculture.” Presented at NESARE Workshop, *Climate Change and Agriculture: Promoting Practical and Profitable Responses,* 2006.