Asian Journal of Advances in Agricultural Research

15(1): 1-7, 2021; Article no.AJAAR.55518
ISSN: 2456-8864

Sustainable Intensification among Smallholder Tobacco (*Nicotiana tabacum*) Farms in Karoi, Zimbabwe

Concilia Mauswa[1] and Norman Mupaso[1*]

[1]Department of Agricultural Economics and Development, Midlands State University, P. Bag 9055, Gweru, Zimbabwe.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAAR/2021/v15i130141
Editor(s):
(1) Dr. Ali E Sharief, Mansoura University, Egypt.
Reviewers:
(1) Ezekia Svotwa, Chinhoyi University of Technology, Zimbabwe.
(2) Hsiu Mei Wang Chen, National Taiwan University of Science and Technology, Taiwan.
(3) Hoang-Dung Tran, Nguyen-Tat-Thanh University, Vietnam.
Complete Peer review History: http://www.sdiarticle4.com/review-history/55518

Original Research Article

Received 01 February 2020
Accepted 04 April 2020
Published 03 February 2021

ABSTRACT

The study's aim was to determine socioeconomic factors that influence sustainable intensification amongst smallholder tobacco farms in Karoi district, Zimbabwe. The study was conducted during the period November 2018 to February 2019. A descriptive approach was used in the study. Primary data were collected using a structured questionnaire. The main aspects measured by the questionnaire were household demographic characteristics, assets owned, livestock ownership, income and expenditure, agricultural production and marketing information. A sample of 91 respondents was chosen using the stratified random sampling technique, with the strata being the four wards in Karoi district. Descriptive statistics together with a multivariate regression model were used to analyse the determinants of sustainable intensification among the smallholder tobacco farms. The main findings suggested a significant relationship between sustainable intensification and use of improved seed ($P=.01$), household-head age ($P=.1$), household wealth index ($P=.01$) and distance to the nearest market ($P=.01$). Based on the findings, the study recommends that agricultural policy strategies should focus on provision of incentives that encourage the smallholder tobacco farmers to adopt environmentally friendly farming practices. Such strategies include, availing agricultural market-places close to the smallholder tobacco farms. Furthermore, the

**Corresponding author: Email: mupaso2@yahoo.com;*

government must support farmers to acquire productive assets so as to enhance their household wealth index, which will eventually lead to sustainable intensification on smallholder tobacco farms.

Keywords: Sustainable intensification; tobacco; smallholder farms; Zimbabwe.

1. INTRODUCTION

Sustainability encompasses the need to balance development activities with environmental wellness, maintenance of resources over time and attaining intergenerational justice [1,2]. A sustainable farming system must be able to cater for the farmer's current needs without compromising the potential of future generations to meet their needs [3]. The principle of Sustainable Intensification (SI) focuses on resource use efficiency with negligible environmental and social damages on a farming unit [4]. SI approaches aim at improving environmental quality, soil fertility, agronomic productivity, profitability, food security and nutrition as well as biodiversity [4]. As a result, SI is foreseen to be the new model of agricultural development in Africa, it is most likely to shift the distribution of benefits and labour demands within and between households [5].

Agricultural intensification results in an increase in the average amount of inputs (that is labour and/or capital) required per unit of land and a shift to production of high-value crops [6]. High population densities and land constraints are the main drivers of intensive use of labour and other agricultural inputs such as fertilizer and improved seed [7,8]. Furthermore, SI is a strategy to mitigate and cope with the stresses of climate change by ensuring resilience of a farming system [9,10]. The preservation of agrobiodiversity enhances the farmer's ability to increase production and reduce climate change induced losses in the short term [11,12].

Most smallholder farmers experience low yields due to limited access to fertile land, improved seeds, credit, infrastructure and technology amongst other resources [13]. Thus, their general challenge is on how to intensify crop production on the existing farm-land, while avoiding a possible decline in soil fertility, environmental degradation and wastage of water resources. In Zimbabwe, most of smallholder tobacco farms are struggling to maintain their production levels due to global warming as they cannot afford to invest in irrigation [4]. Most smallholder tobacco farms in the country are exposed to a variety of climatic hazards as they are located on fragile landscapes. Furthermore, small-scale tobacco producers have limited access to financial and technical resources which are vital to adapt to the changing climate, resulting in the loss of biodiversity, deforestation among other adverse impacts on the environment [4]. Thus, the aim of this study was to provide empirical evidence of how agricultural SI is influenced by a wide range of factors, whose complex interactions give rise to diverse intensification pathways which must be sustainable.

2. CONCEPTUAL FRAMEWORK

The conceptual framework used in the study was adopted from Struik and Kuyper [14]. Fig. 1, illustrates the conceptual framework. The framework argues that SI can be explained in two ways. On one hand, SI is influenced by agronomic science and teaching. Agricultural research and extension services are considered as critical tools to change any given farming system and enhance agronomic sustainability. The agronomic sustainability can be either ecological, economic or social in nature. The social dimension relates to the ability of a given community to develop processes and structures that promote people's wellbeing without compromising the ability of future generations to meet their needs. The ecological aspect, refers to the capability of the environment to meet the needs of the present generation without hindering future generations to meet their needs. Economic sustainability refers to the use of various strategies to utilise the existing resources in an optimal way to achieve a responsible and beneficial long-term balance. On the other hand, SI is an outcome of the interaction of biophysical science, social science and social debates within a given area. The indigenous knowledge and learning systems of a community tend to stimulate an interest towards the inclusion of norms and values to enhance the sustainability of a farming system.

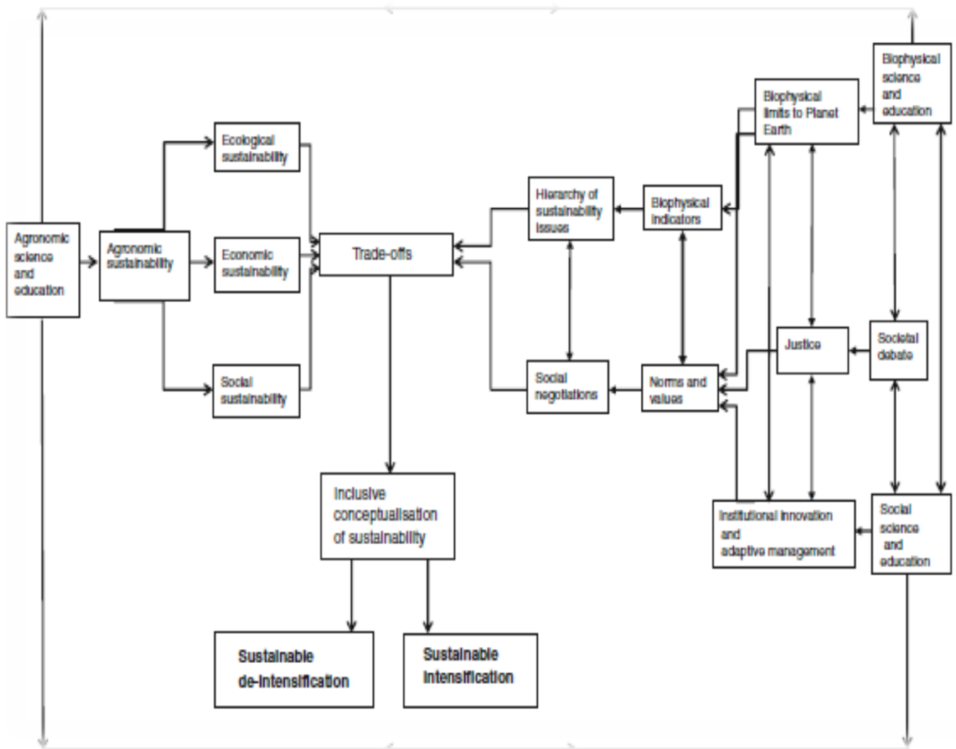

Fig. 1. Conceptual framework for assessing agricultural sustainability.
Source: Adapted from Struik and Kuyper [14]

3. METHODOLOGY

3.1 Description of Study Area

The study was carried out in Karoi district in Mashonaland West Province, which is located in the northern part of Zimbabwe. The district was purposively chosen because it has the majority of smallholder tobacco producers in the country. The geographic coordinates of Karoi district are: 16° 48' 36.00"S, 29° 42' 0.00"E (Latitude: 16.8100; Longitude: 29.7000). The area receives moderate rainfall (approximately 804mm per annum) which is suitable for tobacco production. The mean annual temperature is 19^0C. The main crops grown in the area are tobacco (*Nicotiana tabacum*) and maize (*Zea mays*). Tobacco is the main cash crop whilst maize is mostly grown for subsistence purposes.

3.2 Sampling and Data Collection Methods

Farmer lists obtained from the Tobacco Industry and Marketing Board (TIMB) and Mashonaland Tobacco Company (MTC) were used to select respondents, using the stratified random sampling technique. This was done by grouping the farmers based on four localities (Karoi ward 1, Karoi ward 2, Karoi ward 3 and Karoi ward 4). The sample size was 91 households and it was distributed as follows; 22 households from Karoi Ward 1 and Karoi Ward 2 respectively; 24 households from Karoi Ward 3 and 23 households were from Karoi Ward 4. A structured questionnaire was used to collect primary data from the respondents. The key aspects measured by the questionnaire included household demographic characteristics, asset ownership, livestock ownership, income and expenditure patterns, agricultural production and marketing information.The survey was conducted during the period November 2018 and February 2019. The data collected were for the previous agricultural season. Three trained enumerators assisted with data collection. The data were analysed using Stata software.

3.3 Analytical Framework

The study used a descriptive research design. Descriptive studies attempt to determine, describe or identify what is, with reference to a given phenomenon. This study was concerned with identifying the underlying determinants of SI among smallholder tobacco farms. The data were analysed using descriptive statistics in conjunction with the robust regression model. As suggested by Chayanov's conceptual framework [15] this regression model presents agricultural intensification as a function of demographic variables, agro-ecological variables [16] and market access variables. A multivariate regression model was run. The gross value of crop output was the independent variable and it was regressed on a set of demographic, socio-economic and agro-ecological variables. The multivariate regression model was specified as shown in equation 1:

$$Y = \beta_0 + D_1 + D_2 + D_3 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \beta_{10} X_{10} + \mu_i \quad (1)$$

Where; Y = agricultural intensification (the gross value of crop output per hectare), $\boldsymbol{X_1}$= Access to credit, $\boldsymbol{X_2}$ =Livestock unit, $\boldsymbol{X_3}$ = Total labour cost per hectare ($/ha), $\boldsymbol{X_4}$ =Total improved seed use kg per hectare, $\boldsymbol{X_5}$ = Age*age, $\boldsymbol{X_6}$ =Household head age in years, $\boldsymbol{X_7}$ =Household head years in farming, $\boldsymbol{X_8}$ = Household wealth index, $\boldsymbol{X_9}$ =Total cultivated land (in hectares), $\boldsymbol{X_{10}}$ Distance to the nearest market (km), $\boldsymbol{D1}$, $\boldsymbol{D2}$ and $\boldsymbol{D3}$ are dummy variables representing the three localities (Karoi 1, 2 and 3 respectively).

4. RESULTS AND DISCUSSION

Descriptive statistics and a multivariate regression model were used to measure the study's objectives. Table 1 shows the results of the descriptive analysis. A combination of measures of central tendency and measures of dispersion were used in the analysis. The results (in Table 1) show that tobacco farming is a viable farming enterprise, with an average gross value of US$5910.56 per hectare. However, there seem to be a high variation in returns as reflected by a high standard deviation of US$1064.79.

Table 1. Descriptive statistics for the factors affecting SI

Variable	Mean	Standard deviation	Minimum	Maximum
Gross value of tobacco output per hectare (US$)	5910.56	1064.79	3200	8480
Total hired labour per hectare (labour hours)	52.03	18.29	22	97
Total labour cost per hectare (US$)	291.49	29.12	219	351
Livestock unit	11.13	9.35	0.02	62.61
Total land holding (ha)	5.63	1.62	3	10
Total cultivated land (ha)	4.92	1.40	3	8.5
Total improved seed use per hectare (Kgs)	41.33	20.50	24	102
Distance to the nearest market (Km)	30.37	16.02	4	89
Household wealth index	0.00	1.00	-1.71	2.53
Total fertilizer use per hectare (Kgs)	198.51	88.86	64	494
Cropping intensity (number of crops per unit of time)	398.18	90.95	198	495
Resistance (relative crop loss due to disaster) (Kg/ha)	375.34	177.14	62	960
Stocking rate (number of animals per hectare)	2.08	1.55	0	7
Yield variability (coefficient of variation)	0.90	0.42	0.0615	1.7398
Capital productivity (benefit to cost ratio)	10.12	5.23	3	26
Labour use intensity (hours)	163.42	16.74	112	201
Labour productivity (US$ / person/ day)	35.30	12.91	15	65
Maize yield (Kg/ha)	3857.80	778.10	1500	6500
Tobacco yield (Kg/ha)	1050.04	260.83	500	1767
Maize yield gap (attainable - actual yield) (Kg)	1976.92	1840.42	-1500	6500
Tobacco yield gap (attainable - actual yield)	978.79	795.52	150	5400
Risk (Standard deviation in maize yield/ hectare)	885.31	516.15	141.42	2474.87
Risk (Standard deviation in tobacco / hectare)	334.65	180.14	106.07	954.59

Tobacco is a labour intensive crop, thus, the cost of labour has to be carefully monitored in order to enhance the viability of the enterprise. The findings show that the labour cost per hectare was US291.49, with a low standard deviation (US$29.12). Furthermore, labour productivity (yield per Labour Day of 8 hours) was also measured. The findings show that on average the return per unit of labour per day was US$35.30, thus, labour was being efficiently utilised across the sampled farms. In addition, labour use intensity was measured in order to determine the total number of hours required to complete activities such as land preparation, planting, weeding, fertiliser application, ridging, harvesting and transportation from fields to bans. It was noted that the average time dedicated to tobacco production per season was 163.42hours.

Cropping intensity was measured in order to ascertain the number of different crops that can be grown on the same piece of land or field over a period of a year. The results indicate that on average the sampled farms have a cropping intensity of 398.18 which implies that an average of four crops per agricultural year can be dedicated to the same piece of land. Thus, the tobacco growers can maximise their income per fixed land area [17]. The resistance of the farms to crop loss was also assessed. Loss of yield is mainly due to poor post-harvest handling and poor tobacco curing techniques [18,19]. The results show that an average of 375.34 kg per hectare of tobacco is lost by the smallholder farmers in the study area per agricultural season.

In order to ascertain the determinants of SI, a robust regression model was run. The dependent variable was sustainable intensification. The choice of explanatory variables was made with reference to literature from similar studies. The results of the regression model are shown in Table 2. The R-squared value of 0.5383 implies that approximately 54% of the variation in SI is explained by the independent variables. The F-statistic was significant at 1% level implying that the model was correctly specified. The regression results show that variables such as total cultivated land, farming experience, total labour cost, livestock unit and credit have no significant association with sustainable intensification. Furthermore, variables which were found to be significant in explaining the variation in sustainable intensification were, the distance to nearest market, household wealth index, household-head age and improved seed use.

Table 2. Results of the robust regression model

Variable	Coefficient	Standard error	T- value	P-value	95% confidence interval	
Distance to the nearest market (km)	-12.32	5.62	-2.19	0.031**	-23.52	-1.13
Total cultivated land (ha)	3.93	113.15	0.03	0.972	-221.38	229.24
Household wealth index	1225.30	148.80	8.23	0.000* **	929.01	1521.59
Farming experience (in years)	-27.90	22.17	-1.26	0.212	-72.05	16.24
Household head age (in years)	113.86	64.47	1.77	0.081*	-14.51	242.24
Age*age	-1.01	0.61	-1.65	0.102*	-2.23	0.21
Total improved seed use (kg/ha)	-46.95	7.92	-5.93	0.000***	-62.72	-31.18
Total labour cost ($/ha)	2.15	3.00	0.72	0.476	-3.83	8.14
Livestock unit	3.27	12.57	0.26	0.796	-21.76	28.29
Credit	16.78	170.99	0.10	0.922	-323.71	357.27
Ward 2	-487.13	243.03	-2.01	0.049**	-971.06	-3.20
Ward 3	-317.68	246.34	-1.29	0.201	-808.21	172.84
Ward 4	-515.20	280.69	-1.84	0.070*	-1074.13	43.74
Constant	5493.86	1817.83	3.02	0.003***	1874.10	9113.61
F-statistic	6.90***					
R-Squared value	0.5383					

**** P = .01, ** P = .05 &* P = .1*

The regression results show that there is negative and significant relationship between sustainable intensification and the distance to the nearest market (P=0.05). This implies that the closer the farm is to the market place, the more the incentives for the farmers to intensify their agricultural production. It is assumed that the farmers who are located close to the market-place have an incentive to utilise their resources more efficiently compared to those who are far from the market-place. These findings concur with the postulations by Van Noordwijk et al. [9], who argue that market access is a critical driver of agricultural intensification. Under favourable market conditions, higher yields often translate into higher income returns to the farmer.

The regression results also show that there is a positive and significant relationship between the household wealth index and sustainable intensification. Thus, the more endowed a household is in terms of productive assets, the more likely it is to intensify farm production. The wealth status of a household is assumed to have a positive correlation with the age of the farmer. Hence, as individuals grow older, they tend to accumulate more savings which improves the farm wealth index, under favourable conditions this is more likely to translate into a positive contribution to sustainable intensification. In addition, the household-head age was found to have a positive and significant relationship with sustainable intensification (P=0.1). That implies that the older the farmer is, the more he/she is likely to intensify agricultural production. Age is also a proxy of farming experience. As a result, older farmers are more likely to have more farming experience which makes them utilise farm resources more efficiently than their young counterparts.

The study also found that there is a negative and significant relationship between the use of improved seed and sustainable intensification (P=0.01). This finding suggests that those farmers who utilise improved seed more are less likely to achieve sustainable intensification on their farms. These findings are contrary to the prior expectation. The use of improved varieties is likely to boost yields, while at the same time reducing the production costs.

Furthermore, the effects of the agro-ecological conditions on agricultural intensification is crucial. The agro-ecological conditions were captured in the regression model by the locality dummy variables (Wards 2, 3 and 4). The regression results show that only two of the localities (namely Ward 2 and 4) had significant, though negative relationships with sustainable intensification. These results indicate that there were variations in the general climatic conditions and other bio-physical determinants of agricultural potential in the respective localities. The results also show that the effects of the various independent factors on agricultural intensification are facilitated by the geographic location of the farms.

5. CONCLUSION

Based on the findings, the study concludes that agricultural intensification depend significantly on factors such as the distance of the farm to the market-place, household wealth index, age of household-head, the use of improved seed and the geographic location of the farm. Thus, agricultural policy strategies should focus on the provision of incentives that encourage the smallholder tobacco farmers to adopt environmentally friendly farming practices. Such strategies include, availing agricultural market-places which are close to the smallholder tobacco farmers, so as to enhance sustainable intensification on their farms. In addition, the government must support farmers to acquire productive assets so as to enhance their household wealth index, which will eventually lead to sustainable intensification on smallholder tobacco farms. Farming experience is also of significant importance to the sustainability of the agricultural sector.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Kuhlman T, Farrington J. What is sustainability? Sustainability. 2010;2(11): 3436-3448.
2. Loos J, Abson DJ, Chappell MJ, Hanspach J, Mikulcak F, Tichit M, Fischer J. Putting meaning back into “sustainable intensification.” Frontiers in Ecology and the Environment. 2014;12:356–361. DOI: 10.1890/130157
3. WECD. 1987. Our common future. The report of the World Commission on Environment and Development, Oxford: Oxford University Press.

4. Musumba M, Palm C, Grabowski P, Snapp S. A Framework for selecting and analyzing indicators of sustainable intensification. Forthcoming; 2017.
5. Montpelier Panel. Sustainable intensification: A new paradigm for African agriculture (London: Agriculture for Impact); 2013.
6. Pretty J, Toulmin C, Williams S. Sustainable intensification in African agriculture. Int. J. Agric. Sustain. 2011;9: 5–24.
7. Benin S. Policies and programs affecting land management practices, input use and productivity in the highlands of Amhara Region, Ethiopia. Strategies for sustainable land management in the East African Highlands. 2006;217-256.
8. Pender J, Gebremedhin B. Land management, crop production and household income in the highlands of Tigray, Northern Ethiopia: An econometric analysis. Strategies for sustainable land management in the East African Highlands. 2006;107-139.
9. Van Noordwijk M, Hoang M, Neufeldt H, Yaticht T. (Eds.), How trees and people can co-adapt to climate change: reducing vulnerability through multifunctional agroforestry landscapes. World Agroforestry Centre (ICRAF), Nairobi, Kenya; 2011. Proc. Natl. Acad. Sci. 2007;104:19691-19696.
10. Wezel A, Casagrande M, Celette F, Vian J, Ferrer A. Agroecological practices for sustainable agriculture: A review. Agronomy for Sustainable Development. 2014;34:1-20.
11. Holt- Gimenez E. Measuring farmers' agroecological resistance after Hurricane Mitch in Nicaragua: A case study in participatory, sustainable land management impact monitoring. Agriculture, Ecosystems and Environment. 2002;93:87-105.
12. Altieri MA, Koohafkan P. Enduring farms: Climate change, smallholders and traditional farming communities Third World Network (TWN), Penang, Malaysia; 2008.
13. Rockstrom J, Falkenmark M, Karlberg, H, H, Dieter SR. Future water availability for global food production: the potential of green water for increasing resilience to global change. Water Resources Research. 2009;45(7).
14. Struik PC, Kuyper TW. Sustainable intensification in agriculture: the richer shade of green: A review. Agronomy for Sustainable Development. 2017;37(5).
15. Netting R. Smallholders, householders: farm families and the ecology of intensive, sustainable agriculture. Stanford University Press; 1993.
16. Mortimore, M., Turner B. Does the Sahelian smallholder's management of woodland, farm trees, rangeland support the hypothesis of human-induced desertification?. Journal of Arid Environments. 2005;63(3):567-595.
17. Thompson P. Is sustainability worth debating? In: Debating Science: Deliberation, Values and the Common Good. Humanity Books. 2012a;133–146.
18. Thompson P. The concept and utility of 'ecological thresholds' in biodiversity conservation. Biol. Conserv. 2012b;124, 301–310.
19. Smith K, Barrett CB, Box PW. Participatory risk mapping for targeting research and assistance: with an example from East African pastoralists. World Dev. 2000;28: 1945–1959.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/55518