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Analysis of Agricultural Change Using Field Allocation to Crops Technique: A Case of Uporoto Highlands, Southern Tanzania

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Abstract

Every agricultural system is dynamic as it functions within changing demographic, socio-economic and physical environments. The understanding of agricultural change is important because of its strong relationship to socio-economic, environmental and political systems. This paper discusses the field allocation to crops technique for analysis of changes in crop composition in farming system. The technique is suitable at local scale and in environments where farmers have multiplicity of fields in different locations in order to benefit from micro climates variations. The paper discusses the relevance of studying changes in crop composition for understanding agricultural change and technique's strengths and weaknesses. The technique is demonstrated using data from a farming systems survey in the Uporoto Highlands, Mbeya region, Tanzania. Through capturing gain and loss of fields by crops, the technique unveils changes in the relative importance of crops over time. The technique is relevant for understanding agricultural change with respect to crop composition, and for identification of patterns of changes for better informed decision making.

Keywords: *agricultural change, crop composition, fields allocation to crops technique, Uporoto highlands, Tanzania*

Introduction

Every agricultural system is dynamic as it operates within demographic, socio-economic and physical environments that keep changing over time and space. Agricultural change results as farmers decide on what, where, when, and how to raise crops and animals in response to changing environments. Agricultural change is a phenomenon that has drawn attention of researchers from different fields due to the strong relationship the sector has to many aspects, including demographic, socio-economic, environmental, and political systems. Agricultural change has influence on livelihood, poverty, and food security (Sokoni, 2005). Agricultural change is studied to understand the sector's responsiveness to changes in policies and technological innovations, and its impact on environment (Boserup, 1965;

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Mortimore, 1993; Wiggins, 1995; Ponte, 2001; Sokoni, 2001). Studies on agricultural change serve to support different perspectives on the relationship between agriculture and environment. In this way they enable policy makers, planners and farmers to make informed decisions on agricultural development.

Various techniques have been developed to measure agricultural change. However, there has not been a single technique that is able to capture all changes in the agricultural sector. Often techniques developed vary with the type of change in focus, the availability and reliability of data for measuring the change, the geographical scale of the study; and the purpose of the change analysis. As official statistics are often aggregated and cover larger geographical distribution, studies on local scale changes in agriculture encounter lack of data.

This paper elaborates a technique for analysis of changes in crop composition basing on land allocation to different crops. First, it discusses the relevance of studying changes in crop composition for understanding agricultural change. Second, it presents the field allocation to crop technique and discusses its strengths and weaknesses. Thirdly, the technique is demonstrated by using data collected in a study of farming systems of the Uporoto Highlands, Mbeya region, Tanzania. Finally, the paper concludes by considering the usefulness of the technique and suggests ways through which it may be improved.

Agricultural Change

The effects of population growth on agriculture have been a major subject of explanation for agricultural change. Population growth and associated increase in its density has been considered a driving force for agricultural intensification and improvement in agricultural resource management techniques (Boserup, 1965; English et. al, 1994). This analysis of agricultural change requires a comparison of agricultural productivity in terms of output per unit of and land per unit of time which is eventually considered to be low for extensive agriculture and high for intensive agriculture. However, farm records for capturing labour, capital and labour productivity for determining output input ratios are often not available.

The responsiveness of the agricultural sector to market incentives and disincentives is often captured through measuring changes in agricultural output and supply to the market. An analysis of changes in labour force engaged in agricultural activities and land uses for agriculture may be important for understanding economic change within the sector. It is evident

that various elements are important in understanding agricultural change. These include: crop composition, marketed output, employment; productivity per unit of land; labour composition, etc. No single measure captures agricultural change in its totality. Use of a particular or a combination of techniques may be desirable to suit a particular study. In the next section we focus on the analysis of changes in crop composition at local scale.

Relevance of Changes in Crop Composition

At local scale, changes in crop composition have been an important variable in the study of farming system dynamics. Understanding changes in crop composition in a farming system is important as it reflects linkages of the farming system to prevailing external economic system where market incentives and disincentives influence farmers' decisions on agricultural production. Thus, a change in crop composition may reflect levels of agricultural commercialization. As farmers become more commercialized, there is a tendency to become more specialized. Changes in crop composition also relate to changes in production techniques. Sokoni (2001) noted variations in farming techniques by crops such that, when a crop is abandoned, its farming technique was also abandoned with it. For example, the use of terracing for peas cultivation disappeared with the abandonment of peas cultivation on the Uporoto Highlands. Crops vary in their demands for inputs and land management practices. This phenomenon makes changes in crop composition relevant to the environment. Furthermore, changes in crop composition has relevance and implications to people's livelihoods. A shift towards production of non-food cash crops may be at the expense of decline in food security among rural households.

However, an understanding of changes in crop composition of a farming system and drawing of conclusion on its socio-economic and environmental implications require availability of reliable data at farm level. Yet, smallholder producers rarely keep records of their farm activities and transactions. The use of proxy measures to understand changes in farming system is, therefore, important. Being a proxy measure suggests that a technique does not offer perfect and exhaustive answers, but contributes towards a better understanding of the phenomenon of agricultural change where more accurate techniques are not possible to construct.

Different classifications of crops have been drawn in attempt to understand the relative changes in crop composition. Some of the categories of crops differentiate between cash and food crops; fast and slow crops (Ponte, 1998); erosive and non-erosive crops; and high and low value crops (Wiggins, 1995). The changes in crop composition include some crops and crop varieties being

abandoned or declining in importance. New crops may be adopted, or some crops may gain greater importance than others. Various factors may be responsible for a change in crop composition. It is often difficult to isolate a single factor for any such change. However, some association can be established between a change in crop composition and a certain variable.

The Field Allocation to Crops Technique

This section describes the field allocation to crops technique for understanding farming systems dynamics. The technique is suitable at local scale and in environments where farmers have multiplicity of fields in different locations. This is often common in areas with significant variations in micro-climates and economic conditions such that farmers benefit from diversification of their field locations. The technique assumes that farmers are able to assign a major crop to each field despite the fact other minor crops may be grown on the same fields. The advantage of this technique is that it focuses on major crops as considered by farmers themselves. However, the major crops do not necessarily mean higher income earners to households. A limitation is that where areas of fields are not available, a crop may gain in terms of number of fields where it could have lost in terms of area cultivated. The technique is, therefore, open for inclusion of more variables to make it more informative and closer to reality.

The technique is based on recording all fields accessed by a household over a study period. It also identifies the date of acquisition of each of the field. For each field farmers are required to indicate the major crop to which the field was allocated and the specific date. A researcher has the freedom of capturing dates relevant to one's study. For each date selected, the data is summarized in a matrix of crops showing the number of fields in respect of each crop. The columns and rows of the matrix represent two dates under comparison. In each cell, the number of fields that were allocated to a respective crop are entered. The matrix will bear row and column total, which summarize the total number of fields allocated to a crop at each time period under the analysis. The grand total shows the total number of fields recorded from all households studied.

The technique has several advantages. It establishes the relationship between crops with respect to farmers' allocation of fields. It captures not only which crops have gained or lost fields, but also the crops to which they lost or gained. A loss of field by one crop implies a gain by another or several others. Similarly, a gain of field by one crop implies a loss by another. On the basis of gain and loss of fields by crops, it is possible to assess the relative importance of crops. It is possible to establish from which crop(s) a

crop is gaining land, and to which crop(s) a crop is loosing fields. The technique gives a temporal perspective of change that can be analyzed at the level of all crops and at the level of an individual crop.

However, the technique has some limitations. The first limitations relates to the assumption that each field is allocated a major crop. In intercropping systems it may be easy to identify a major from a minor crop. Also, the technique assumes that there is production only once a year for each field. This may be more complicated where farmers adopt more frequency of cultivation of the same field for different crops. The technique underrates intermediate allocation of fields to crops. However, these limitations may be minimized if the user adopts the technique to the specific situation of his study. The following section illustrates the use of field allocation to crops using data from the Uporoto Highlands.

Changes in Crop Composition in the Uporoto Highlands

Description of the study area

The Uporoto Highlands are part of the Southern Highlands of Tanzania, which are known for their great potential for agricultural production. The altitude ranges from 1900~2400m above sea level. The area receives adequate rainfall between 1000 to over 2000mm per year. The soils of the area are of volcanic origin and relatively fertile. The topography of the area is mountainous and hilly, with rugged plateaux often bisected by numerous stream valleys, giving a land of ridges separated by stream valleys. The valley sides are often very steep. Of recent cultivation of crops has been extended further to valley bottoms.

The area used to rely on pyrethrum production as a major cash crop. The socio-economic importance of pyrethrum has been taken over by Irish potatoes. Other cash food crops include wheat, cabbages, onions and vegetables in warmer areas. The main food crop is maize. Households have small, fragmented farms and plot multiplicity in different locations is common. This a means of farmers diversifying crop production to take advantages of varying micro-climates. A rapid pace of agricultural commercialization is also taking place.

Changes in Crop Composition – General Analysis

Quantitative analysis of changes in the area under cultivation of different crops is difficult to estimate because crops are grown on very small, isolated and scattered fields whose exact dimensions are unknown. Often a number of crops are inter-cropped, and the same field can be used for the same or different crops, 2~3 times within one year. Andersons' (1996:85) study in potato cultivation in the Uporoto Highlands encountered the same problem

of quantifying changes in potato production. This section describes the changes in crop composition in the Uporoto Highlands using the technique of field allocation to crops.

The number of fields per household ranged from 2 to 19. For the purpose of this analysis, data was recorded for up to 10 fields only per household. The objective of the analysis was to identify changes in the field allocation to different crops in each household at 3 different periods: now (at the time of survey), prior, and after a field was acquired by a household. Unfortunately, the date of field acquisition was not recorded. Users of this technique may employ more specific dates than those used here.

Tables 1-3 present matrices of fields allocated to crops at different times of the study. A comparison of allocation of fields to crops in 1997, prior and after their acquisition by households shows some remarkable changes in crop composition. The change between before and after field acquisition indicates which crop fields previous owners chose for disposal. Also, it indicates the new field owners' allocation of acquired field to various crops.

Table 1 shows the relationship between allocation of fields to crops before and after the households acquired the fields. More than half (71) of the fields that were under Irish potatoes prior to field acquisition by current households had remained under the same crop after acquisition. Only 17 and 13 fields were changed to maize and wheat respectively. This indicates that Irish potatoes remained an important crop.

Table 1: A Comparison Between Field allocation to Crops Prior and after field acquisition by Households (by number of fields)

Crops in fields	After Field Acquisition												
Prior	*IP*	*Mz*	*Cb*	*Ps*	*Wt*	*On*	*Bn*	*Pyr*	*Cf*	*Pr*	*Fl*	*Ot*	*Total*
Irish Potatoes	71	17	8	2	13	0	1	5	0	0	4	5	123
Maize	134	248	12	12	55	15	7	23	11	1	7	29	535
Cabbage	3	0	0	0	0	0	0	0	0	0	0	0	3
Peas	16	16	2	17	15	0	0	6	1	0	2	7	82
Wheat	31	26	2	12	55	0	7	4	3	0	1	25	147
Onion	0	0	0	0	0	2	1	0	0	0	0	1	3
Beans	1	2	0	11	5	2	4	1	0	0	0	1	17
Pyrethrum	64	42	7	2	12	1	2	45	3	1	4	9	188
Coffee	0	0	0	0	0	2	0	0	3	0	0	2	7
Pori	67	16	8	7	9	4	3	10	1	4	0	12	131
Fallow	16	6	3	3	3	4	0	3	0	1	3	5	44
Other	11	26	0	5	10	3	4	3	3	0	2	14	81
All	**422**	**401**	**42**	**62**	**178**	**32**	**29**	**101**	**25**	**7**	**23**	**51**	**1373**

Key: IP = Irish Potatoes; Mz = Maize; Ps = Peas; Cb = Cabbage; Wt = Wheat; On = Onions; Bn = Beans; Pyt = Pyrethrum; Cf = Coffee; Pr = Pori; Fl= Fallow; Ot = Other

Wheat retained 55 out of 147 of its fields, lost 31 fields to Irish potatoes and 26 fields to maize. But it gained 55 fields from maize and 13 from Irish potatoes. Maize retained 248 of its 535 fields before acquisition, and lost 134 fields to Irish potatoes and 55 fields to wheat, but gained 64 fields from pyrethrum. Over one-third (16 out 44) of the fields under fallow were allocated to Irish potatoes. Irish potatoes also took 67 fields of fresh land (*pori*). Pyrethrum shows a greater loss of fields. It retained only 45 of its fields and lost 64 fields to Irish potatoes and 42 fields to maize. It gained only 23 fields from maize.

Table 2 compares the distribution of fields to crops in *now* and *before* their acquisition by households. Irish potatoes retained 60 of the fields with a loss of 25 fields to maize and only 14 fields were left under fallow. Maize still held 194 of the fields; it had lost 134 fields to Irish potatoes and about 79 fields to wheat. Of all the 148 fields allocated to wheat before current households acquired them, 63 have remained under wheat; 32 had been allocated to Irish potatoes and 21 fields to maize. Irish potato has taken 20 fields that were under fallow; and 12 fields under fallow were taken by maize. Again, Irish potatoes took a greater share of the fresh land ('*pori*') (64 out of 132 fields), while only 13 fresh fields were allocated to maize. Cabbage and wheat took 10 fields each from fresh fields. This indicates that pyrethrum has been a major crop that has been responsible for the clearance of virgin land for agriculture. Pyrethrum had a greater loss of its share of fields. It has retained only 2 out of 188 fields. Most of its fields were replaced by Irish potatoes (68), maize (40), and wheat (29).

Table 2: A Comparison between Field allocation to Crops in Now and Prior to Field acquisition by Households (by number of fields)

Crops in fields	After Field Acquisition												
Prior	*IP*	*Mz*	*Cb*	*Ps*	*Wt*	*On*	*Bn*	*Pyr*	*Cf*	*Pr*	*Fl*	*Ot*	*Total*
Irish Potatoes	60	25	7	3	9	2	1	2	0	0	14	0	123
Maize	134	194	22	12	79	19	9	7	15	5	24	15	535
Cabbage	2	0	1	0	0	0	0	0	0	0	0	0	3
Peas	23	16	1	15	16	2	2	0	1	1	4	1	82
Wheat	32	21	2	7	63	1	7	1	4	0	4	6	148
Onion	0	0	0	0	1	1	1	0	0	0	0	0	3
Beans	0	2	0	1	6	2	5	1	0	0	0	0	17
Pyrethrum	68	40	9	3	29		3	2		0	22	5	188
Coffee	0	0	0	0	0	2	0	0	3	0	0	2	7
Pori	64	13	10	5	10	6	3	3	1	3	12	2	132
Fallow	20	12	1	1	6	7	0	0	1	0	6	1	55
Other	19	21	1	3	18	5	6	1	4	0	3	2	82
All	**421**	**344**	**55**	**50**	**237**	**51**	**37**	**17**	**32**	**9**	**89**	**33**	**1375**

Key: IP = Irish Potatoes; Mz = Maize; Ps = Peas; Cb = Cabbage; Wt = Wheat; On = Onions; Bn = Beans; Pyt = Pyrethrum; Cf = Coffee; Pr = Pori; Fl= Fallow; Ot = Other

Table 3 shows the matrix of changes in field allocation to crops between time after plot acquisition by households and the crops grown in 1997. The change between field allocation to crops after acquisition of fields by households and 1997 indicates that coffee retained all its fields, and gained a few from wheat, maize and potatoes. Other crops that retained a greater proportion of their fields were Irish potatoes (275 out of 422 fields), maize (250 out of 404 fields), and wheat (132 out of 179).

Table 3: A comparison Between Crops Grown *Now* and *After* Field Acquisition by Households

Crops in fields	After Field Acquisition												
Prior	*IP*	*Mz*	*Cb*	*Ps*	*Wt*	*On*	*Bn*	*Pyr*	*Cf*	*Pr*	*Fl*	*Ot*	*Total*
Irish Potatoes	275	44	14	5	32	4	6	1	1	1	29	10	422
Maize	73	250	3	2	40	5	1	4	1	2	18	5	404
Cabbage	9	1	30	0	2	0	0	0	0	0	0	0	42
Peas	2	8	0	39	10	1	0	0	0	0	2	0	62
Wheat	14	16	1	2	132	1	1	1	2	1	8	0	179
Onion	0	0	0	0	0	33	0	0	0	0	0	0	33
Beans	1	0	0	1	1	1	24	0	0	0	1	0	29
Pyrethrum	26	15	7	0	15	2	1	11	0	1	21	2	101
Coffee	0	0	0	0	0	0	0	0	25	0	0	0	25
Pori	2	0	0	1	1	0	0	0	0	3	0	0	7
Fallow	2	6	0	0	2	3	0	0	2	0	8	0	23
Other	17	7	0	0	3	2	3	0	1	0	2	16	51
All	**421**	**347**	**55**	**50**	**238**	**52**	**36**	**17**	**32**	**8**	**89**	**33**	**1378**

Key: IP = Irish Potatoes; Mz = Maize; Ps = Peas; Cb = Cabbage; Wt = Wheat; On = Onions; Bn = Beans; Pyt = Pyrethrum; Cf = Coffee; Pr = Pori; Fl= Fallow; Ot = Other

But pyrethrum retained only 11 out of its 101 fields. About one-fifth of the pyrethrum fields were kept fallow. The reason for this could be, first, that the fields required regaining fertility to be used for other crops. Second, reports from farmers suggest that exit from pyrethrum growing was gradual. The overall picture shows that field allocation to maize and peas declined, while those of Irish potato, cabbage and wheat increased. The decline in pyrethrum crop's share of fields is due to marketing problems encountered in the 1980s, which included decline in producer prices, and impromptu payment to farmers (Sokoni, 2001).

Analysis of the Tables 1~2 shows that there has been a decreasing importance of pyrethrum, whereas that of Irish potatoes and wheat has increased. The decreasing trend of allocation of fields to pyrethrum and the consequent decline in production is not peculiar to Uporoto Highlands. This has also been observed also in Makete district (Mwamfupe, 1987). The allocation of fields to maize has remained fairly stable, perhaps since this is a key food crop. The greater allocation of fallow and fresh land (*pori*) to Irish

potatoes seem to confirm that demand for land for potato production has contributed to the clearance of virgin forested land of the Uporoto Highlands.

Changes in Crop Composition - Individual Crop Analysis

The decline in the importance of pyrethrum on the Uporoto Highlands demands a greater attention. This was a major cash crop of the area, and both government authorities and farmers suggest that its decline has had repercussions in the economy of households. Moreover, effort is being made to revive its production.

A major change in crop composition in the Uporoto highland farming systems is the continuing disappearance of pyrethrum, formerly the main and dominant cash crop. Pyrethrum was introduced in the Southern Highlands in the 1930s. Initially white settlers produced the crop on large-scale farms, but later its production spread among smallholder producers. Of all the households covered in the sample, 65.5% had grown pyrethrum before, and about a third (30%) had never grown pyrethrum. Only 5.5% were growing pyrethrum in 1997. The latter were found in Iwalanje and Ulenje villages. These finding differ from those of an earlier study (Nalitolela, 1990), which found that 49% of the sample of households from the Uporoto and Umalila Highlands were cultivating pyrethrum. This indicates that a major part of the decrease in pyrethrum occurred since 1990.

Figures 1~3 give specific allocation of fields that were under pyrethrum to different crops. Of all plots that were under pyrethrum prior to their acquisitions by current households, only 23.4% remained under pyrethrum after transfer. 34% of the plots previously under pyrethrum were replaced by Irish potatoes and 22.3% by maize, 6.4% by wheat, and only 3.7% by cabbage (Fig. 1).

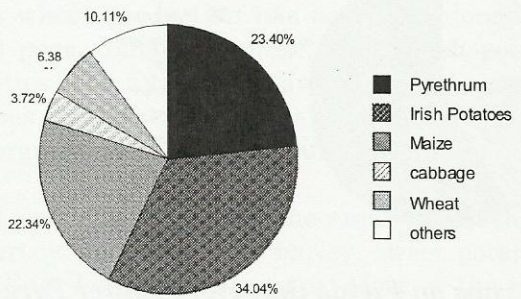


Figure 1: ***Crops Which Replaced Pyrethrum Following Plot Acquisition by Households***

In Fig. 2, the analysis of the land use on plots now gives yet another indication of the changes. Of all the 101 plots that were put under pyrethrum after their acquisition by current households, only about 11% are under pyrethrum. 25.7% of them have been replaced by Irish potatoes; 20.8% by fallow; 14.9% by maize; 14.9% by wheat; 6.9% by cabbage and 5.9% by other crops.

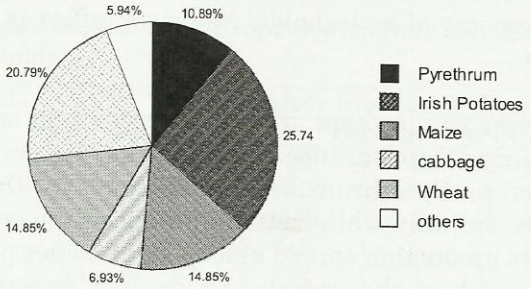


Figure 2: ***Current Crops on Plots which were under Pyrethrum Cultivation after Household Field Acquisition***

Furthermore, Fig. 3 compares the current use of plots to their use prior to acquisition by current households. Of all the plots that were under pyrethrum prior to their acquisition by the households, only 1.1% have remained under pyrethrum. Irish potatoes have replaced a greater proportion (36.2%). 21.9% of the pyrethrum plots have been replaced by maize; 15.4% by wheat; 11.7% are under fallow; 5.3% by cabbage and 9% by other crops.

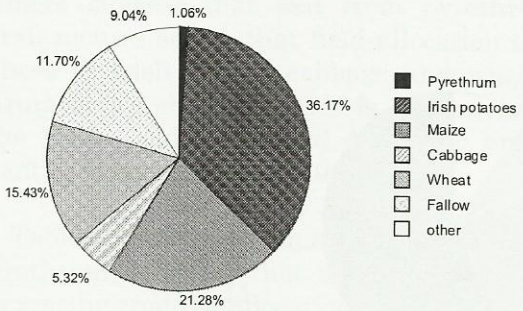


Figure 3: ***Current Crops on Fields that Were Under Pyrethrum Cultivation Prior to their Acquisition by Households***

The above analysis shows that the number of pyrethrum fields declined and were largely taken over by Irish potatoes, maize and wheat. Most of the households stopped pyrethrum production between 1991~1995. Overall Irish potatoes, maize, wheat, fallow and trees have been the main crops/land uses which have replaced pyrethrum. Irish potatoes, wheat, maize are the key crops that have replaced pyrethrum.

The decline in the importance and production of pyrethrum is not peculiar to the Uporoto Highlands. There has been a decline in pyrethrum production at the regional and national levels. Fig. 3 shows the trend in pyrethrum production in Mbeya region. The area under pyrethrum production has dropped from the peak of 4792 hectares in 1991/92 to only 850 hectares in 1997/98, and production levels have dropped from 1598 tonnes to 139 tonnes respectively.

The unfavourable competition of pyrethrum with other crops is one of the reasons for its decline. Mwamfupe (1987) found that pyrethrum was more labour demanding and had less return to labour than other crops such as Irish potatoes. However, this reason may not still hold. The demand for labour and return to labour for Irish potatoes may have changed because earlier Irish potato growing relied on natural fertility of the newly cleared land. From the early 1990s such land for agricultural extension is not available. The shift in allocation of fields from pyrethrum in favour of Irish potatoes has made land available for the expansion of Irish potatoes cultivation. However, former pyrethrum fields, unlike fresh cleared virgin land, required use of external inputs to make production viable. Thus, the use of chemical inputs has made Irish potatoes growing more capital and labour demanding. This explains the often-said willingness of farmers to go back to pyrethrum growing. But uncertainty in the market for the crop is perhaps a major bottleneck to this.

Other crops whose production has been abandoned by households include yellow (dry) peas, tomatoes, maize, some Irish potato varieties and some wheat varieties. The availability and improved access to better varieties of Irish potatoes and wheat has enabled farmers to respond favourably to various emerging marketing opportunities.

Other crops previously grown in the area but which were not significant in the 1997 survey were sorghum, barley, sweet potatoes and *numbu* (*coleus esculentus*, Eng. Livingstone potato). Most of the crop abandonment took place 10 years before 1997. This has probably some relationship to the changing marketing conditions in Tanzania following the structural

adjustment programs undertaken from mid-1980s. As whole pyrethrum, Irish potatoes, maize and wheat have replaced most of the plots which in the past were under peas and cabbages.

Conclusion

Despite the weaknesses of the techniques discussed above, the field allocation to crops technique proves valuable and relevant for understanding agricultural change with respect to crop composition. It is capable of drawing a general analysis of gain or loss of fields for each crop at times specified by a researcher. A researcher has the option of the presenting the data in percentages of the total number of fields for a crop at a specific period.

Analysis at individual crop level has also proved very useful. Here only one crop was selected for analysis. However, one a matrix has been constructed, a researcher can undertake of each crop separately. The observations can be presented using statistical diagrams to the choice of the user. It is, therefore, a suitable technique for understanding changes in crop-diversity and changes in the relative importance of crops. It is suitable for use in situations where farmers own numerous small scattered fields in which different crops are grown.

The technique is also open for improvement by the user. More details on the time component, land tenure, land management practices, may be added to widen the scope of its use. The technique is significant for understanding changes in faming system and for identification of patterns of changes for better informed decision-making. It is fairly simple and draws results that are significant for policy interventions.

References

Anderson, J.A. 1996. Potato Cultivation in the Uporoto Highlands, Tanzania. An Analysis of the Social Nature of Agro-technological Change. *African Affairs*, 95:85 –106.

Boserup, E. 1965. *Conditions of Agricultural Growth: the Economics of Agrarian Change Under Population Pressure.* London: George Allen & Unwin Ltd.

English, J., M. Tiffen, & M. Mortimore, 1994. *Land Reform Management in Machakos District, Kenya 1930–1990.*

Mortimore, M. 1993. Population Growth and Land degradation. *GeoJournal* 31 (1): 15–21.

Mwamfupe, D. 1987. Agricultural Decision Making. M.A. Dissertation, University of Dar es Salaam.

Nalitolela, A.J. 1990. A diagnostic Survey Report of the Uporoto-Umalila Highlands of Mbeya Region. Mbeya: Uyole Agricultural Centre.

Ponte, S. 2001. Policy Reforms, Market failures and Input Use in African Smallholder Agriculture. *European Journal of Development Research,* 13 (1): 1–29.

Ponte, S. 1998. Fast Crops, Fast Cash: Market Liberalisation and Rural Livelihoods in Songea and Morogoro Districts, Tanzania. *Canadian Journal of African Studies* 32 (2): 316–348.

Sankhayan, P.L. 1995. Effect of Structural Adjustment Policies on Resource Management at Peasant Household Level in Tanzania. *Norwegian Journal of Agricultural Sciences* No. 21: 13–30.

Sokoni., C.H. 2001. The Influence of Agricultural Marketing Reforms on Highland Farming Systems in Tanzania: The Case of the Uporoto Highlands, Mbeya Region. PhD thesis, University of Dar es Salaam.

Sokoni, C.H., & T.C. Shechambo. 2005. Changes in the Upland Irrigation System and Implications for Rural Poverty Alleviation. A Case of the Ndiwa Irrigation System, West Usambara Mountains, Tanzania.

Wiggins, S. 1995. Change in African Farming Systems between the Mid 1970s and the mid 1980s. *Journal of International Development* 7 (6): 807–848.