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# Land Access in the Development of Horticultural Crops in East Africa. A Case Study of Passion Fruit in Burundi, Kenya, and Rwanda

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**Abstract:** Rapid population growth in fertile agricultural lands of East Africa creates land scarcity, which has become a major hindrance to land access for the introduction of new horticultural crops. But their introduction in these areas is increasing, because of their high market price, which improves farmers' income. As such, this research evaluated land access dynamics (availability, acquisition, and use changes) on the introduction of passion fruits in East Africa. The study used purposeful sampling to collect information from 171 passion fruit farmers from Burundi (60), Kenya (51), and Rwanda (60) through interviews during field surveys. Among the respondents from all three countries, inheritance and land purchase were the predominant modes of land access (>50% and >21%, respectively). Furthermore, the substitution of other crops by passion fruits was high (>60%) among Kenyan and Rwandan farmers, but low (18%) among Burundian farmers. Our findings indicate that land access influences the patterns of adoption of new crops, since, when limited in supply, it may require the acquisition of new land space, abandonment of other crops, or opting for mixed farming. As such, land access should be a consideration in the promotion of new crops for sustainable agricultural ventures.

**Keywords:** access to land; passion fruit; Burundi; Kenya; Rwanda

## 1. Introduction

Rural smallholder farmers are central in the supply of agricultural products to agro-industries, consumer-oriented local markets, and export markets at the regional or international level. They are central in attaining food security and contribute substantially to economic growth. However, these farmers in sub-Saharan Africa have poor access to land resources and as a result, this undermines their potential in spearheading economic development and improvement of livelihoods [1–3]. The current advances in the adoption of new crops by these farmers have the potential to alter their roles and contribution to food and export products. For example, the adoption of passion fruits by rural smallholder farmers may result in changes in land use, income generation, and food security among participating households and their communities. In the recent past, a tendency of farmers to shift from cereal crops

(wheat and maize) cultivation to high-value horticultural crops has been observed in East Africa, but the impact of such changes on food supply and sufficiency has not been well evaluated [4,5].

High population pressure in sub-Saharan Africa contributes to the rapid development of settlements. This promotes the clearance of forests and grasslands for settlements and crop cultivation [6]. Moreover, high population pressure causes an increase in land fragmentation, which hinders sustainable and productive agricultural ventures [6,7]. Most farmers in rural areas have small pieces of land (less than 1.5 ha), as a result of land fragmentation caused by inheritance of land resources [8,9]. Furthermore, these farmers have limited alternative sources of income, hence, they lack the potential to expand their farmlands [1].

Land rights in East Africa include customary land tenure systems, trust land tenure, and private land tenure systems. Customary land tenure systems comprise land resources collectively owned by communities, they are common in Kenyan pastoralist communities found in semi-arid and arid areas as well as in similar communities of both Burundi and Rwanda [10]. Government trust land is owned by the state corporations and other public institutions, such as public parks, public offices, public institutions, public land reserves, and protected areas [11]. Private land owned by individuals is normally under freehold or leasehold terms. Trust and private lands are formally registered and there is the issuance of title deeds. Land registration is well organized in Kenya, but poor in both Burundi and Rwanda [12]. Challenges to legal rights to land in the latter are due to poor regulations, for example, land rights in Burundi are poor since a majority of landowners do not possess legal documents proving their ownership [6,13]. There is a lack of sufficient regulations to support customary land tenure systems in the three study countries, therefore, some of such lands are not registered. Furthermore, communal land tenure systems face challenges of land-use conflicts within or between members of the communities. On the other hand, women have low access to customary land [7,14]. However, the development of democracy and new regulations have promoted East African states to ratify international conventions on natural resource conservation involving the management of land resources, such as Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC), and United Convention to Combat Desertification. There is potential that such developments will promote the improvement of land policies and regulations.

Land inequalities began during colonization through dispossessions of land from African communities [15], at independence, new challenges comprising poor access to resources by the Africans, high economic pressure, an urgency to maintain the productivity of white settler farms, and the need for compensation of departing white settlers resulted in the poor transfer of ownership of the land resource, promoting high land access to political elites, skilled Africans, and other wealthy Africans [15–17]. Post genocide Rwanda, on the other hand, has faced a challenge of land redistribution [18], while persistent civil wars in Burundi have resulted in the displacement of people from their lands. Since this country is densely populated, returning internally displaced refugees often found their land already occupied by other people, hence resulting in a pressure of land reallocation, social tension, and land disputes [6,19,20].

At present, most rural areas in Burundi, Kenya, and Rwanda are densely populated [21,22]. This contributes to land scarcity for agricultural activities such as crop cultivation, as such, farmers have challenges of increasing their cultivated land. With limited resources, they could increase their cultivated land through land purchase and land rental markets [1,21]. Besides, land scarcity could pressure farmers to increase land productivity for high income; such changes have previously involved intensive farming and adoption of high-value horticultural crops such as fruits and vegetables. These agrarian changes associated with the intensification of agricultural production and the high population growth raise questions on the sustainability of rainfed agriculture [6]. Previous studies have observed that changes resulting in abandonment of food crops for the benefit of horticultural crops affect food production and supply [4].

Passion fruit is a common horticultural fruit crop adopted by rural households in East Africa that have small agricultural land sizes [5]. However, the impacts of the introduction and adoption of this fruit crop in rural areas of Burundi, Kenya, and Rwanda are unknown. Previous studies have

strongly suggested that the present upsurge in the uptake of new horticultural crops, including passion fruits, would increase farm income [3], but there is lack of sufficient data to support this, furthermore, there is an absence of data on how land access challenges affect the adoption of horticultural crops and the likely impacts on income and food supply. Thus, there is a need for research to evaluate how land access and associated land-use changes affect the introduction of horticultural crops among rural smallholder farmers. Therefore, this study evaluated land access and land-use changes associated with the adoption of the passion fruit by smallholder farmers in East Africa and provides a critical assessment of probable long-term effects in the context of land scarcity.

## 2. Materials and Methods

### 2.1. Choice and Description of Study Areas

Key regions for passion fruit production in Burundi, Kenya, and Rwanda were selected for the study. In Burundi, Matongo and Isare are the main passion fruit production regions (Figure 1) [5,23,24]. Matongo municipality receives an average annual rainfall ranging from 1200 to 1600 mm per annum with an average temperature of about 18 °C. Isare, on the other hand, receives an average rainfall of 1100 to 1800 mm per annum with an average temperature range of 17 to 23 °C [25]. In Kenya, Embu and Meru counties are the major passion fruits growing regions (Figure 2) [5,26,27]. These regions have adequate and well-distributed rainfall (600 to 1800 mm per annum), temperature regimes range from 12 to 26 °C, and the soils are fertile and well-drained [28,29]. In Rwanda, Nyamagabe and Rulindo are the major passion fruit production regions (Figure 3) [5,30]. The average annual rainfall for these two regions ranges from 1300 to 2300 mm per annum with an average temperature range of between 18 and 19 °C [30,31].

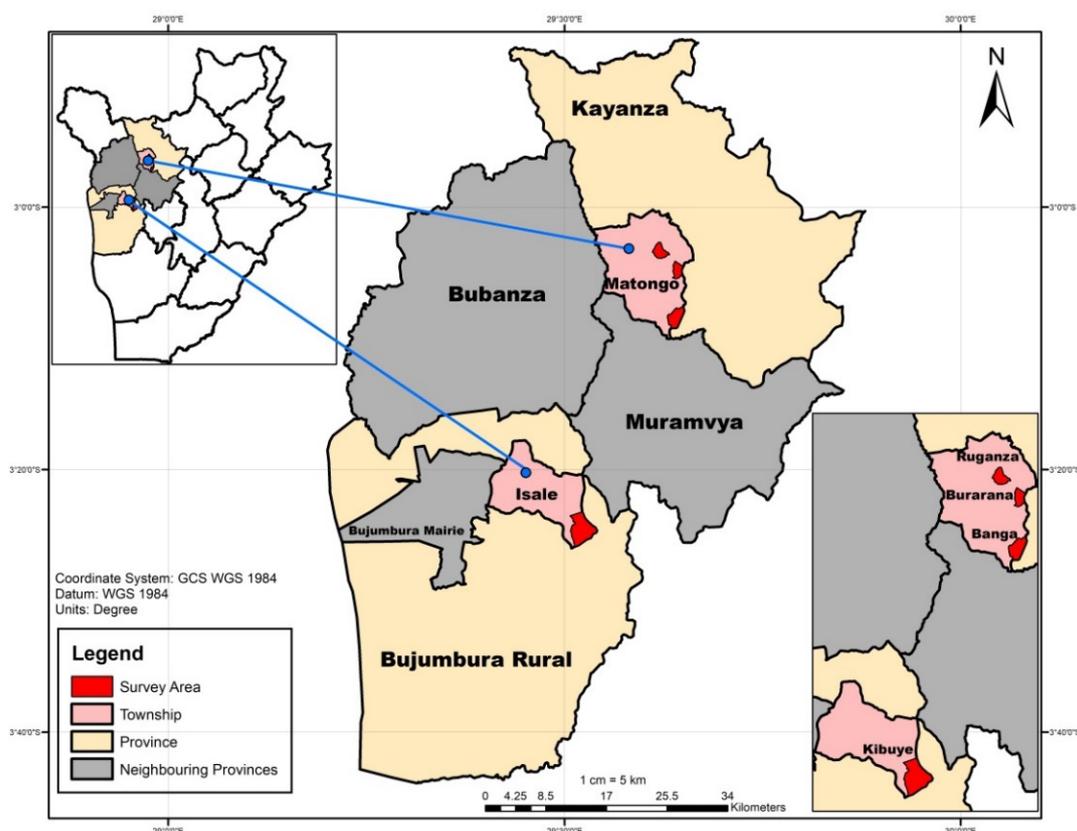


Figure 1. A map showing the study regions in Burundi.

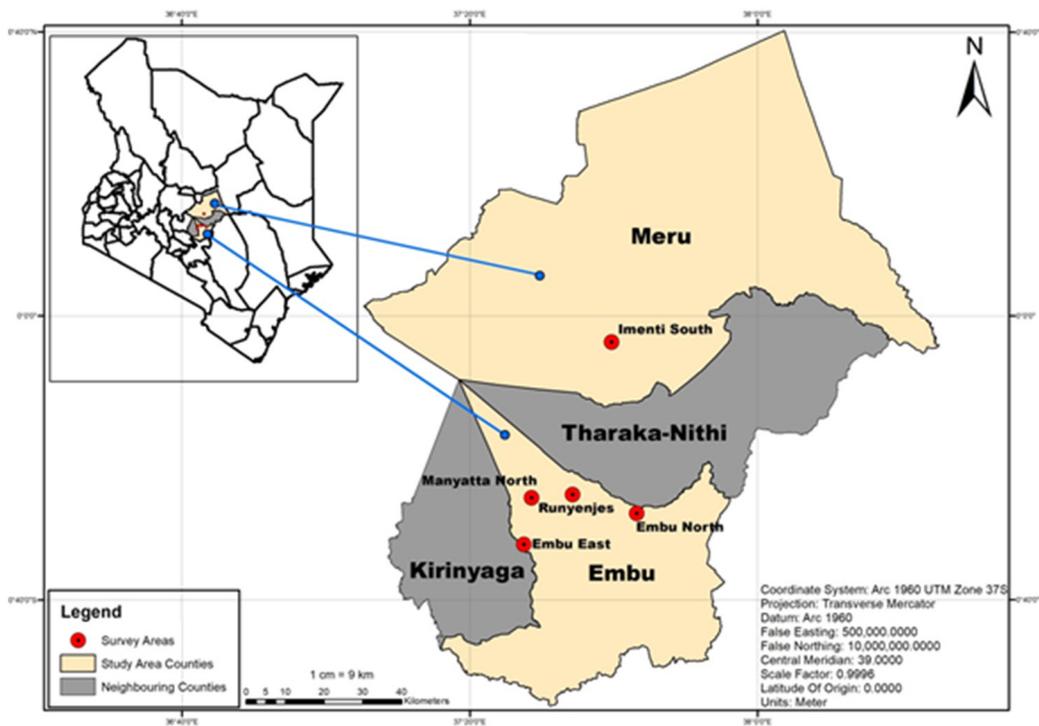


Figure 2. A map showing the study regions in Kenya.

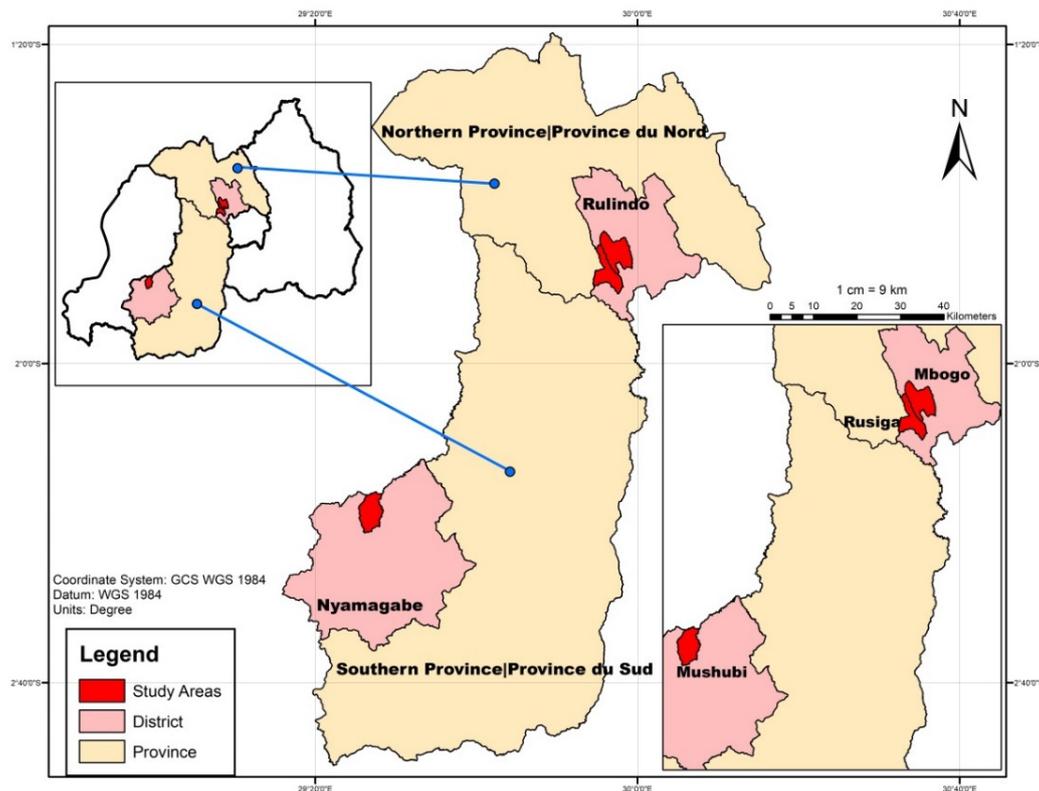


Figure 3. A map showing the study regions in Rwanda.

## 2.2. Research Design

The study employed ex post facto research design involving exploratory surveys, the use of semistructured interviews with key stakeholders, and field observations. To understand the trajectory

of adoption of the passion fruit, we used the snowball approach where the municipal extension officers/agronomists and index farmers introduced researchers to the most experienced passion fruit farmers. The latter, in turn, identified other farmers who adopted this crop. As such, we were able to obtain the first sample of 135 farmers in Burundi through the assistance of extension officers and index farmers. The exploratory survey in Burundi revealed that respondent farmers with less than three years of passion fruits farming had limited knowledge on the actual production costs, cost-effective production management practices, and knowledge on the available support systems from the country's horticultural sector. Therefore, we included only farmers with at least five years of experience in passion fruit production. These experienced farmers were part of our in-depth investigation whose results are the subject of this article.

### 2.3. Sample Size Estimation and Sampling

The starting sample in each country was 135 farmers, as used in the exploratory survey. Therefore, to determine the appropriate sample size, we adopted the Yamane formula [32].

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

where  $n$  is a sample size,  $N$  is the total target population, and  $e$  is the level of precision with  $N = 135$  and  $e = 10\%$ .

Purposeful sampling was used in the study, and according to the Yamane formula, a sample of 58 respondents was arrived at. However, in the survey, the achievable sample size of farmers with five years of experience in passion fruit production was 60 in Burundi, 51 in Kenya, and 60 in Rwanda, leading to a total of 171 passion fruit farmers.

### 2.4. Data Collection and Analysis

Semistructured interviews advocated by trained field officers led the discussions, observations, and interviews. The interlocutors could express themselves as freely as possible, and this allowed the interviewers (field officers) to capture the details of the situation at the farm level before and after the adoption of the passion fruit farming. Field observations combined with field surveys allowed the collection of reliable information on farm characteristics.

The data collected through surveys and field observations were used to determine the total agricultural land, number and sizes of plots under passion fruits production, farming systems used in passion fruit production (monoculture or polyculture), and information on farm space occupied by other crops. These data were organized in excel files and subjected to qualitative statistics using SPSS Statistics software (version 20.0. IBM, Armonk, NY, USA, 2018). The results were in the form of averages, frequencies, and standard deviations. Farm sizes data from the surveyed farmers in the three study countries were further subjected to analysis of variance using R software version 3.6.0, and the significant means were separated by the Student Newman Keuls Test (SNK test) at  $\alpha = 0.05$ .

To analyze land fragmentation, the estimated average land area possessed by respondent passion fruit farmers in each study country was considered as the total land area in a typical passion fruit farming household. The majority of households had a size of four in Kenya, five in Rwanda, and six in Burundi; on average the mean household size for the surveyed farmers was five. Similarly, literature had indicated a high fertility rate of women in rural areas of East Africa, where each married woman was expected to have between 5 and 6 children [33,34]. As such, we adopted five children per household as a standard representative number of heirs per household as well as the expected number of heirs in the subsequent generations. Land access by inheritance was considered, hence, the average farm size per household was divided by five to allow each heir to have his/her share, for the first, second, and third generations, respectively.

### 3. Results

#### 3.1. Land Area Available for Agricultural Activities among Surveyed Farmers

Among the passion fruit farming households included in the study from the three study countries, the average farm sizes ranged from 0.8 ha, 0.9 ha, to 2.7 ha in Rwanda, Burundi, and Kenya, respectively. The proportion of small farms (<1.0 ha) was high in Burundi (68%) and Rwanda (78%), but low in Kenya (6%). The proportion of medium-sized farms (1.0 ≤ 2.0 ha) was moderate in Kenya (39%) and Rwanda (23%), but low in Burundi (10%). A majority (55%) of passion fruit farms in Kenya were large (>2.0 ha) (Table 1). The average farm size for Kenyan farmers included in the study was significantly higher compared with that of farmers in Burundi and Rwanda (Table 2). Similarly, the sizes of farms dedicated to passion fruits production in Kenya were significantly larger compared with those of farmers in Burundi and Rwanda (Table 3).

**Table 1.** The proportion of farm sizes of the households included in the study.

Country	Proportion of Farm Sizes		
	<1 ha	1 ≤ 2 ha	>2 ha
Kenya (51)	5.96%	39.18%	54.86%
Burundi (60)	68.34%	23.33%	8.33%
Rwanda (60)	78.30%	10.03%	11.67%

**Table 2.** Mean farm size of the households included in the study.

Country	Mean Farm Size ± Std. Error (ha)
Kenya (51)	2.73 ± 0.24 a
Burundi (60)	0.88 ± 0.10 b
Rwanda (60)	0.83 ± 0.16 b
<i>P</i> -value	<0.001

Means with the same letters within a column are not significantly different at the SNK test, alpha = 0.05.

**Table 3.** Farm area under passion fruit production among households included in the study.

Country	Mean Farm Size ± Std. Error (ha)
Kenya (51)	0.67 ± 0.08 a
Burundi (60)	0.34 ± 0.05 b
Rwanda (60)	0.23 ± 0.04 b
<i>P</i> -value	<0.001

Means with the same letters within a column are not significantly different at the SNK test, alpha = 0.05.

The spatial occupancy of land under passion fruits (monoculture and polyculture farming) compared with other crops among the surveyed households was moderate in the three countries: Burundi, 39%; Rwanda, 28%; and Kenya, 25%, (Table 4).

**Table 4.** Spatial occupancy (ha) of crops grown in the farms surveyed.

Crops and Cropping System	Kenya	%	Burundi	%	Rwanda	%
Monoculture passion fruit	19.40	13.95	4.60	8.68	10.40	20.97
Polyculture passion fruit	14.90	10.71	15.80	29.81	3.60	7.26
Other crops	104.80	75.34	32.60	61.51	35.60	71.77
Total	139.10	100.00	53.00	100.00	49.60	100.00

### 3.2. Modes of Land Acquisition among Surveyed Farmers

Three modes of land access were identified during the fieldwork, they comprised inheritance, purchase, and leasehold. Inheritance was observed to be the main mode of land acquisition for passion fruit production by the surveyed farmers in the three countries, and it was reported by 75%, 59%, and 55% farmers in Burundi, Kenya, and Rwanda, respectively. Land purchase for passion fruit production was high in Rwanda (41%) and moderate in both Kenya (33%) and Burundi (21%). Leasing land for passion fruit production was low among surveyed farmers in all the three study countries, ranging from 8%, 5%, to 4% in Kenya, Burundi, and Rwanda, respectively (Figure 4).

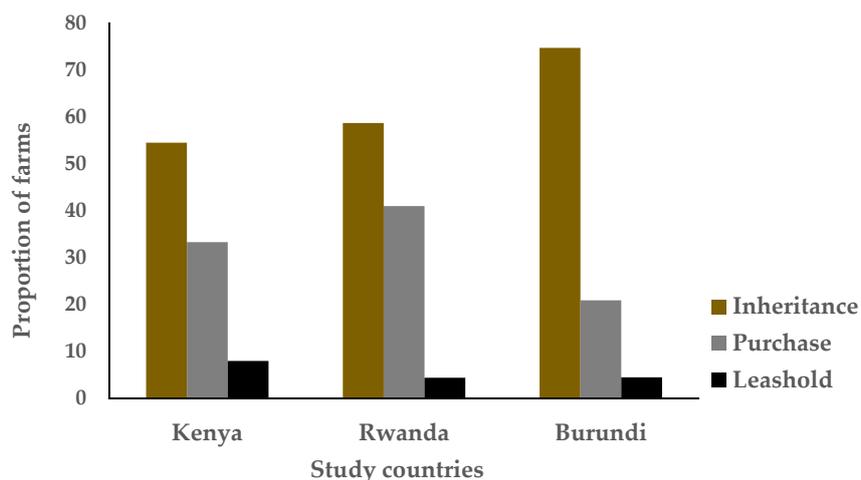


Figure 4. Land access patterns among surveyed passion fruits farming households (in %).

The inheritance, which was observed to be the predominant method of land access, could be a contributor to land fragmentation, hence a factor in the reduction of farm sizes possessed by individual households; this could have occurred as the land resource was passed from one generation to the other. For example, in Burundi, with an average of 0.882 ha per household of five heirs, each inherits 0.176 ha in the first generation, 0.035 ha in the second, and 0.007 ha in the third generation (Table 5 and Figure 5).

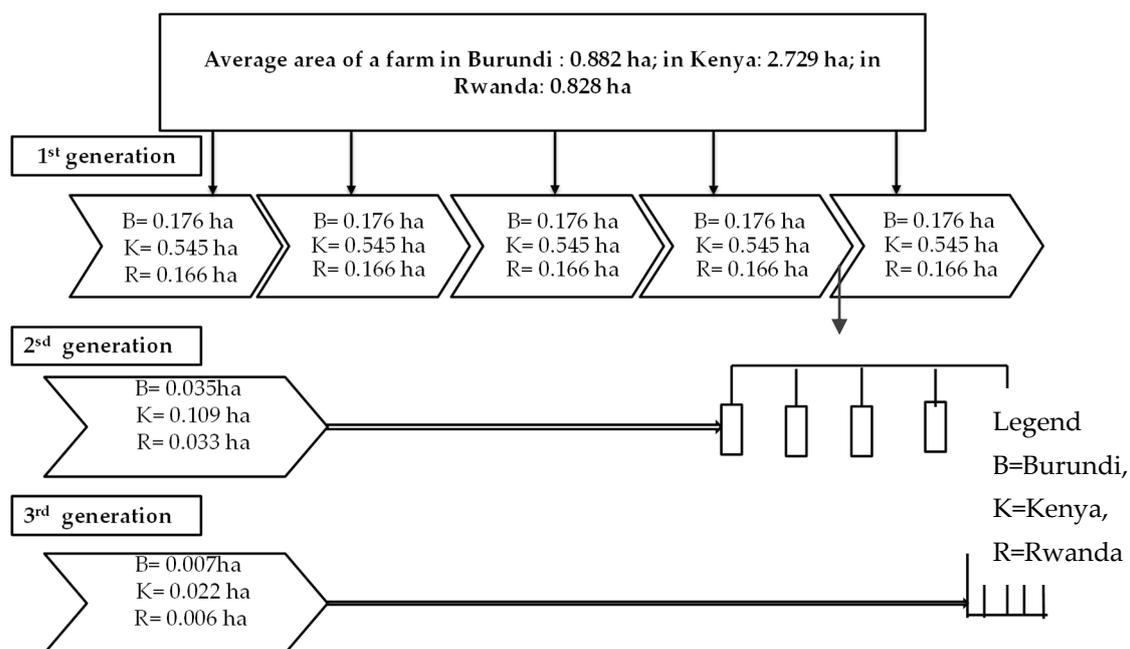


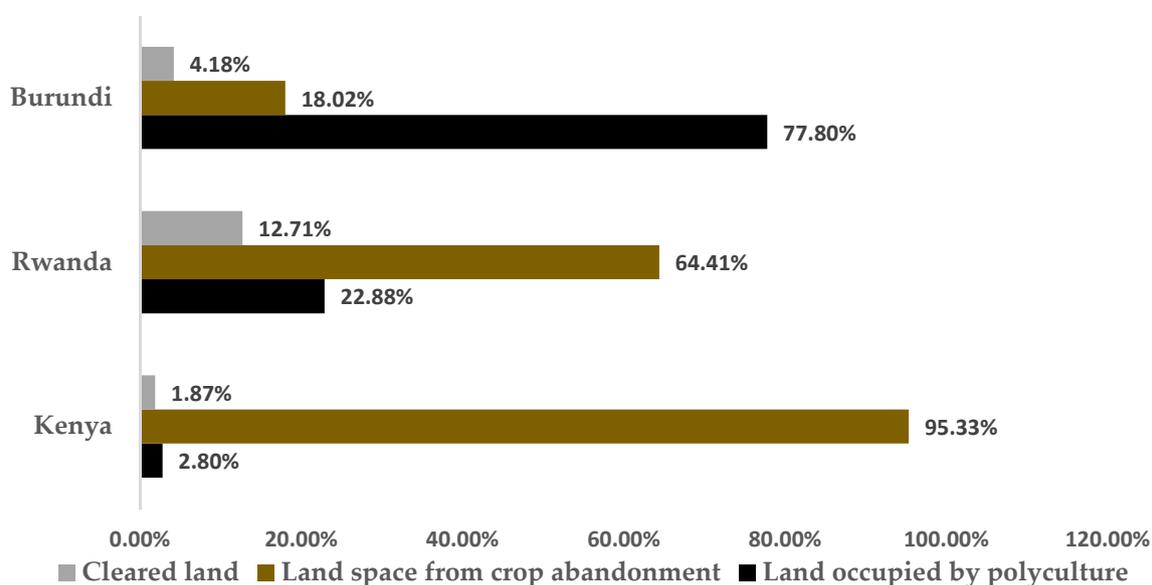
Figure 5. Land fragmentation during inheritance for households with an average of five children.

**Table 5.** Household size characteristics for the surveyed passion fruit farmers.

Country	Minimum	Maximum	Modal	Mean
Kenya	01	09	04	4.22
Burundi	02	10	06	5.87
Rwanda	01	10	05	4.75

### 3.3. Land Use Changes among Surveyed Farmers during the Adoption of Passion Fruit Production

In Kenya, most of the land under passion fruit production was previously used in the production of other crops (95%). Land-use change from other crops to allow passion fruit production was also high in Rwanda (64%) but low in Burundi (18%). Polyculture farming was observed to be high in Burundi (78%), moderate in Rwanda (23%), and low in Kenya (3%). Clearance of land to allow passion fruit production was low in the three study countries, ranging from 13% in Rwanda, 4% in Kenya, to 2% in Burundi (Figure 6).

**Figure 6.** Origin of the land used in passion fruit production among surveyed farmers.

Crops abandoned to pave way for passion fruit production were diverse: food crops, cash crops, vegetable crops, fruit crops, forage crops, and agroforestry trees. Food crop abandonment was high in all three countries. Rwanda registered the highest level of food crop abandonment (97%), followed by Burundi (88%) and Kenya (55%), respectively. Abandonment of cash crops was absent in the surveyed farms in Rwanda but present at low rates in both Kenya (15%) and Burundi (5%). Abandonment of vegetable crops was high in Kenya (17%) but low in both Burundi (2%) and Rwanda (1%). Cases of fruit crops and forage abandonment were absent in Burundi and Rwanda but present in Kenya at low rates (3% and 9%, respectively). Abandonment of agroforestry trees was low in the three study countries (Table 6).

**Table 6.** Frequency of abandoned crop categories.

Types of Crops Abandoned	Kenya	Burundi	Rwanda
Food crops	55.29%	87.73%	97.33%
Cash crops	14.48%	5.17%	0.00%
Vegetable crops	17.14%	1.78%	1.27%
Fruit crops	2.59%	0.00%	0.00%
Forage crops	9.20%	0.00%	0.00%
Agroforestry trees	1.30%	5.32%	1.40%

### 3.4. Methods Used in Increasing Land Available for Passion Fruit Production

Methods used by surveyed farmers to increase land availability for passion fruit production comprised land purchase, polyculture farming, and crop abandonment. The land purchase was high in Rwanda (95%) and Burundi (88%), but moderate in Kenya (52%). Although polyculture practices were low in the three study countries, more farmers undertook this practice in Kenya (16%), followed by Burundi (12%) and Rwanda (3%), respectively. Crop abandonment as a method of increasing land resources available for passion fruit production was only observed in Kenya (31%) and Rwanda (3%), but absent in Burundi (Table 7).

**Table 7.** Strategies to increase land resources for passion fruits production.

Strategies	Kenya	Burundi	Rwanda
Purchase of land	52.24%	88.37%	94.60%
Practicing polyculture	16.42%	11.63%	2.70%
Crop abandonment	31.34%	0.00%	2.70%

### 3.5. Land Area under Different Passion Fruit Cropping Systems among Surveyed Farmers

Monocropping of passion fruits was observed to cover small farm sizes in all the three countries, Burundi (0.15 ha), Rwanda (0.26 ha), and Kenya (0.50 ha) (Table 8). However, on average, Kenya had significantly larger monoculture plots compared with both Burundi and Rwanda (Table 9). The maximum land area under passion fruit monoculture was 1.50 ha in Kenya, 0.90 ha in Burundi, and 2.0 ha in Rwanda. On the other hand, the average farm area under passion fruit polyculture farming was significantly high in Kenya compared with Rwanda and Burundi (Table 10). In terms of the proportion of surveyed passion fruit farmers adopting either monocropping or polyculture farming, Kenyan and Burundian farmers were observed to allocate more farmland to mixed farming with an average of 1.06 ha in Kenya compared with 0.34 ha in Burundi and 0.18 ha in Rwanda (Table 8).

**Table 8.** Farm area (ha) under different passion fruit cropping systems among surveyed farmers.

Farm Area Characteristics	Cropping System					
	Burundi		Rwanda		Kenya	
	Monoculture	Polyculture	Monoculture	Polyculture	Monoculture	Polyculture
Mean	0.15	0.34	0.30	0.18	0.50	1.06
Minimum	0.01	0.01	0.01	0.01	0.10	0.40
Maximum	0.90	1.75	2.00	1.05	1.50	2.00
Std. deviation	0.23	0.39	0.36	0.29	0.33	0.60

**Table 9.** Farm sizes under passion fruits monocropping.

Country	Mean Farm Size $\pm$ Std. Error (ha)
Kenya (51)	0.50 $\pm$ 0.05 a
Burundi (60)	0.15 $\pm$ 0.04 b
Rwanda (60)	0.26 $\pm$ 0.06 b
<i>P</i> -value	< 0.001

Means with the same letters within a column are not significantly different at the SNK test, alpha = 0.05.

**Table 10.** Farm sizes under passion fruit in polyculture farming.

Country	Mean Farm Size $\pm$ Std. Error (ha)
Kenya (51)	1.06 $\pm$ 0.16 a
Burundi (60)	0.34 $\pm$ 0.06 b
Rwanda (60)	0.18 $\pm$ 0.06 b
<i>P</i> -value	<0.001

Means with the same letters within a column are not significantly different at the SNK test, alpha = 0.05.

## 4. Discussions

### 4.1. Agricultural Land Area Owned by Farmers Practicing Passion Fruit Production in East Africa

In this study, the majority of farmers adopting passion fruit production in Burundi, Kenya, and Rwanda were observed to have relatively small to moderate farm sizes. These observations are closely related to previous studies where horticulture farmers practicing passion fruits production in East Africa were observed to have small farm sizes [28,35,36]. The probable explanation to this is the steady decline in land available for various economic activities in many rural areas of East Africa; a key contributor to this is the high population pressure [1,21]. These observations are contrary to the expectation that larger farms are more likely to adopt passion fruits production or other new crops due to their high potential to manage risks associated [37]. The scenario in these three countries is a little different. Poor living conditions due to limited income may be the driving force for these smallholder farmers to risk venturing in the production of new horticultural crops.

Despite the small farm sizes among the surveyed farming households, the findings of this study indicate that households devoted large farmland to passion fruits compared with other crops. This is similar to other reports, where passion fruits were allocated more space than other crops in Kenya, Burundi, and Rwanda [5]. The allocation of large farm space to passion fruit production in comparison with food crops may indicate a reduction in food production. This may harm food supply for such households, especially when the limited food supplied at markets becomes expensive and unaffordable. The situation is complex, and there may be a need for refinancing food crops despite their replacement by passion fruits since food crops have key roles in food and nutritional security, however, there is also the knowledge that the newly introduced crops such as passion fruits are in an urgent need of financing for research in the development of their production [38–40].

### 4.2. Modes of Land Access in the Adoption of Passion Fruit Production among Farmers in East Africa

Land tenure systems dictate the availability of land for economic ventures, and farmers with large tracts of land have been observed to have a high ability to adopt new crops compared to smallholder farmers. However, the majority of rural farmers in East Africa have small-sized farms, but they are observed to adopt passion fruit in their crop production activities despite the small farm sizes. Common methods of land access observed among these rural farmers are described below.

#### 4.2.1. Inheritance

The majority of responded farmers in the study countries had acquired their land through inheritance. In other studies, rural farmers in sub-Saharan Africa have always relied on the inheritance

of land resources from their families [1,41]. This is a traditional mode of land access and has both advantages and disadvantages. Through inheritance, a new generation of farmers, with a higher level of education, take up the ownership of land, these farmers are more exposed to modern farming practices and are likely to favor improved crop farming practices such as increased use of farm inputs, sustainable farming methods, and adoption of new high-value crops [42,43]. Therefore, we believe farmers inheriting land are likely to try the adoption of new crops and this explains what was observed from farmers in the three countries. In previous studies, young farmers were observed to adopt new sustainable and efficient production practices compared with older ones [44]. Moreover, the high rate of land inheritance among surveyed farmers in East Africa would promote land subdivision, which would result in reduced land resources per household. This would promote the buildup of pressure among farmers to adopt new high-value crops, better land management practices (crop rotation), sustainable soil nutrient management, high-input-use efficiency, and crop diversification [45,46]. Such changes would potentially cushion against huge losses in unexpected market price fluctuations and risk of losses associated with monoculture farming and ensure a steady income to farmers [47–49].

Although land fragmentation is a common phenomenon under high population growth in many parts of rural sub-Saharan Africa [7,50,51], estimates from this study indicate that this practice may create a danger of reduced economical value of the fragmented farmlands [41]. In India, land fragmentation has been associated with increased inefficiencies in farm activities and a reduction in net profits [45]. The potential problem of land fragmentation among surveyed passion fruit farmers may be much more complex than a result of land inheritance since there are evidence of poor reallocation of land to internal refugees, especially in Burundi and Rwanda. It is unknown how the small pieces of land reallocated to the internal refugees would be inherited. On the other hand, limited resources among smallholder farmers hinder the acquisition of new parcels of land (for increasing farm sizes), and sometimes smallholder farmers sell their land to generate finance for other uses or as a method of obtaining immediate benefits; this has been observed in Asia and other parts of the world [52,53]. Very few rural farmers could save some income for use in buying or leasing land for their agricultural production.

#### 4.2.2. Land Purchase

In this study, the purchase of agricultural land among respondent farmers was moderate. This agrees with previous reports that indicate low capital among rural smallholder farmers [3]. However, we observe tendencies of farmers to buy land, which may indicate that farmers adopting passion fruit production in East Africa have alternative sources of income or they have savings, which they could use to acquire inputs for their agricultural production. On the other hand, possible factors promoting land purchase by passion fruit farmers comprise migration, lack of land to inherit, population growth, and political crisis. Farmers have also been observed to sell their land in events of political crisis and lack of income to cope with unforeseen and urgent expenses [53,54]. On the other hand, some rural farmers sell land to obtain finances for other uses, for example, changing agricultural production systems from traditional to modern input-intensive systems promoted the sale of agricultural land among poor farmers in a highly populated region of western Kenya [55]; such events may result in increased poverty among smallholder farmers.

In Burundi, land purchase in rural areas was prohibited before the 1980s by the ancestral customs which considered land as a common heritage. A similar stance can also be seen elsewhere in Africa. In another study, it has been illustrated that rural societies often oppose the sale of land to prevent access by other clans or immigrant families [56]. But in the face of the high demand for more agricultural land, such customs are eroding and this has promoted land purchase as a mode of land access in sub-Saharan Africa [50,57]. The main beneficiaries of land sales are often the average households who want to be able to produce more food on a larger farm, save money, or conserve the land resource as an asset to pass on to their offspring. Thus, land no longer has the sole function of agricultural production but also functions as capital and reserve of assets. This situation may promote retention or reacquisition of land by wealthy households [58]. However, the sale of agricultural land owned by the

rich would enhance land redistribution to poor smallholder farmers and landless peasants; this has previously been observed in some parts of Africa [53,57].

It has often been thought that the inheritance mode of land access is the main cause of land-use pressure due to increased subdivision and the need for intensification of agricultural land. But we also suspect that the intensification of production systems, changes in eating habits, and market demand may be contributing to land-use pressure. In this study, we noted that the majority of passion fruit farmers in the three study countries were purchasing land to increase the farm sizes. This indicates that passion fruit farmers could make savings to improve their production a likely indicator of an increase in income from the sale of passion fruits. This is evidence that supports the potential of passion fruit to increase the income of farmers. This is supported by work done by Bashangwa Mpozi [5] which estimated that integrating 781 passion fruit plants in one hectare of coffee/banana system would provide farmers with an additional annual income of about 1148 USD/ha/year in Burundi and 2686.64 USD/ha/year in Kenya. In addition to land purchase, some farmers were observed to practice polyculture as a strategy to increase land for passion fruit production. This indicates that farmers adopting passion fruit production are aware of sustainable production systems which will enhance increased income to farmers [59–62].

#### 4.2.3. Leasehold

Leasing of land by farmers in the three study countries for passion fruit production was low. In other studies, especially in vegetable production, the leasing of land is very high [62]. But our observations are similar to the reports on the land rental markets in sub-Saharan Africa. Previous studies indicated a rate of between 6% and 21% [50]. Furthermore, leasehold has been observed to be less common among passion fruit farmers in East Africa compared with smallholder farmers in other countries, particularly in West Africa [62]. Challenges that might have contributed to low leasehold among respondent farmers consist of poor leasehold contracts in East Africa. In East Africa, leasehold agreements are temporal for a limited period of about three years and have been linked to the discouragement of farmers from long-term investments [50]. However, this mode of access to land is becoming increasingly important in high-density areas where land has become scarce and highly fragmented [63,64], for example, the growth of land rental markets in Malawi have been promoted by high population density [64]. Some studies show that rental markets contribute to increased use of land resources in economic activities even where sales have had an opposite effect [65,66]. Other studies suggest that land leasing can serve as a safety net for poor smallholder farmers and also improve the living conditions of these farmers, and landowners may also benefit from the money paid by tenants [1,65,67].

Land tenure security for farmers is synonymous with using the rented land for a period that allows them to benefit from the investments made. Land tenure security, therefore, influences decisions on the adoption of new agricultural technologies that improve soil quality, agricultural production, and the adoption of promising innovations. On the other hand, land insecurity limits the possibility of making long-term agricultural investments, for example, there is evidence of low adoption of agricultural technologies such as agroforestry linked to land tenure insecurity and poor regulations of rental markets in sub-Saharan Africa [1,50]. Furthermore, tenure insecurity caused by inefficient rental markets has been associated with poor productivity of rented land in Ethiopia [67]. Farmers growing passion fruits in insecure land are deterred from investing in practices like soil erosion management using hedges, using sustainable irrigation systems, and agroforestry due to the fear of breaching their rental contracts or not being able to benefit from such investments in the events of lack of renewal of their lease contract.

Land tenure security has a great influence on land resource development through the adoption of new agricultural technologies [3,68–72]. This may comprise ventures directed at improving soil quality through the use of organic fertilizers, the set up of irrigation systems, and practicing agroforestry. On the other hand, land insecurity limits the possibility of making long-term agricultural investments [1,50].

For example, there is evidence of the low adoption of agricultural technologies such as agroforestry linked to land tenure insecurity [3,67]. In our study, we observed some level of tenure insecurity among the few farmers engaged in leasehold arrangements, since some of their lease arrangements were verbal or written on papers without legal value and in the absence of witnesses, while some of the written/documented leasehold contracts could not be registered by rural administration following the absence of legal rights to land by landlords, especially in Rwanda and Burundi. In such cases, leases were based on trust. Therefore, there is an urgent need for setting up of legal procedures, policies, and regulations to guide agricultural land rental markets in Burundi, Kenya, and Rwanda. This view is in line with the concerns of the Strategic Framework for Horticulture Development in Burundi, which calls for the establishment of a legal framework that would guarantee the use of agricultural land leased for at least five years with a focus on sustainable agricultural land use [68]. Such developments would allow formalizing and security to all leasehold contracts.

In general, there are several potential benefits from the rental market, such as increased agricultural production in rural areas as well as the creation of nonagricultural employment opportunities. Some of the nonagricultural jobs would comprise managers for land markets and public services in charge of land issues. Also, the cadastral services could provide mapping services for the rented land, which could favor the mapping of agricultural lands in rural areas and greatly reduce land conflicts. As such, reforms for better regulation of land rental markets appeared to be urgently needed in East Africa to promote the expansion of agricultural land and enhance increased agricultural production.

#### *4.3. Methods of Increasing the Land Area for Passion Fruits Production*

Respondent farmers were observed to abandon crops, practice polyculture, and to clear vegetation to increase land available for passion fruits production. These methods of increasing agricultural land are common to other crops as well and they have been observed in many parts of sub-Saharan Africa. Where farmers opt to practice polyculture, there are increased advantages of reduced weeding requirements, increased access to mulching materials (especially the leaves from other crops), reduced pests and disease attacks, and provision of green manures [59,60,70–73]. Besides, passion fruits in polycultures can benefit from the nitrogen fixed by legumes. Farmers may also use the income from the other crops to finance passion fruit production. For example, coffee and tea sales have been reported to finance passion fruit production in Burundi [35]. Furthermore, Le Roy [74] observed that applications of fertilizers to cotton and other industrial crops could benefit food crops, hence we believe that food crops would be able to benefit from previous crop management practices done in passion fruit farms. On the other hand, food crops could benefit from funds obtained from the sale of passion fruits and used in the purchase of quality seeds, fertilizers, and payment of agricultural labor.

#### *4.4. Land Access and Passion Fruits Integration Approaches into Crop Production Activities of Farmers Surveyed*

Passion fruit integration strategies differ from country to country and from farmer to farmer. The results of this study indicate that it was common for farmers in Burundi who adopt the passion fruits to combine them with existing crops. While farmers adopting the passion fruits in Kenya and Rwanda would use land that was previously occupied by other crops. Land clearing was also more pronounced in Rwanda than in Burundi and Kenya. These results show that there is some land-use competition between passion fruits and other crops, this was also manifested by crop abandonment, and such observations have also been documented previously during the introduction of new crops [4,75]. Food crops were the most replaced by passion fruit in Burundi and Rwanda compared with Kenya, while market gardening, fodder crops, and agroforestry were commonly replaced by passion fruits in Kenya. Previous studies have observed the replacement of coffee and cotton farming in Tanzania with rice and maize production [75]. In the context of East Africa, the replacement of some crops with passion fruit does not imply the total replacement of these crops, but it may be an indicator of reduced production of the abandoned crops. As seen in the majority of the surveyed farmers, there was the cultivation

of diverse crops, although, competition between passion fruit and other crops for space was evident, and this is important for sustainable agricultural ventures. It is even beneficial that alongside the competitive relationship between passion fruits and other crops concerning the use of agricultural land, there are other complementary relationships where these crops benefit from each other, as illustrated by Bashangwa Mpozi [5] who noted that income from passion fruit could be used to finance food crops and other perennial crops in Burundi, Kenya, and Rwanda.

#### *4.5. Influence of Land Access and Land Sizes on Passion Fruit Cropping Systems in East Africa*

Among the respondent farmers, there were two common passion fruit cropping system, monoculture and polyculture farming. Monoculture was characterized by small land sizes in the three countries, Burundi, Kenya, and Rwanda. The probable reason for such small farm sizes is the high population pressure and persistent land subdivision in rural areas of East Africa. Similar observations have previously been reported by Karani-Gichimu and Limo [28,36]. Kenyan and Burundian households were observed to have slightly larger intercropped farms compared with Rwanda, and the probable reason is that in general, Kenyan farmers in this study were observed to have fairly large farm sizes, while Burundian farmers preferred to integrate passion fruits to other crops rather than abandon crops or subdivide farm plots. Previous studies have suggested that when farmers are faced with challenges of limited land for crop cultivation, they are likely to practice polyculture [76]. Polyculture is an intensive farming method common in densely populated areas, a characteristic similar to rural parts of Burundi, Kenya, and Rwanda included in this study. Limited polyculture in Rwanda may indicate less land access pressure among some of the farmers adopting passion fruits production. Farming in Rwanda is picking up as immigrants are returning to the country; most of the farmers are just beginning to invest and this may be a reason for lower cases of polyculture. The practice of polyculture among passion fruit-adopting farmers in East Africa indicates an increase in sustainable farming practices. This practice would safeguard against crop abandonment and contribute to crop diversification, which is associated with increased sustainability and greater resilience to pests in agricultural production systems [77,78].

## **5. Conclusions**

This study has shown that land access among rural passion fruit farmers in Burundi, Kenya, and Rwanda is through inheritance, purchase, and leasehold arrangements. Land purchase and leasehold systems are modern methods of land access; therefore, they could indicate the modernization of agricultural practice among smallholder farmers in these countries. These changes could also indicate an increase in the value of agricultural land and increased income for rural smallholder farmers. Since some of the surveyed farmers were found to buy land as well as abandon other crops to pave way for passion fruit production, it appears that there could be some type of attraction for this crop; monetary, high nutritional value, or other benefits. Crop abandonment could affect food production and, in some cases, affect household income, especially when the prices of passion fruits fall. As such, this situation reveals the need to regulate the different modes of access to agricultural land to guarantee sustainable agricultural production and also to avoid dysfunctions that may accentuate land conflicts. Governments of these countries should consider land issues in public development agendas, especially through promoting set up of clear policies on land purchase, registration, and leasehold procedures. Local authorities should also train their communities on strategies for an equitable share of communal land for agricultural activities, as well as discourage widespread farmland fragmentation through inheritance. Empowerment of rural farmers through agricultural sector financing could also increase the ability of these farmers to purchase land for the cultivation of new crops such as passion fruits.

## **6. Recommendations**

Adoption of high-value horticultural crops is supported for the increased income of rural farmers in East Africa, however, constraints on land access may limit the achievement of optimum income

from the cultivation of these crops. Therefore, efforts should be directed on the improvement of land access and tenure security in rural areas of East Africa.

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