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# Avocado Production and Local Trade in the Southern Highlands of Tanzania: A Case of an Emerging Trade Commodity from Horticulture

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Received: 25 October 2019; Accepted: 8 November 2019; Published: 12 November 2019

**Abstract:** Avocado crop in Tanzania is sparingly investigated regardless of being an important fruit commodity. This study was undertaken to explore the yield and the value chain of this crop in the country. Data were collected mainly by face-to-face interviews with 275 avocado farmers, 231 avocado traders and 16 key informants. Descriptive statistics, Chi-square test and one-way analysis of variance were used for data analysis. The average crop yield ranged from 76 to 124 kg plant$^{-1}$ between regions. The average price for the farmers' produce ranged from US$ 0.30 to 0.45 kg$^{-1}$ between regions. About 72% of the farmers were dissatisfied with avocado business whereas 79% of the traders were pleased with it. A number of challenges were found hindering the development of the avocado industry in Tanzania, which in turn affects the fruit yield and the value chain. Addressing these challenges at the national, regional, district and village levels is important for improving the livelihood of Tanzanian farmers growing this crop, given the fact that a good proportion of the country's population is employed in the agricultural sector and most of the reported challenges also affect the value chain of other crops.

**Keywords:** smallholder farmers; value chain; yield

## 1. Introduction

Avocado (*Persea americana* Mill.), also known as butter fruit, is a nutritive healthy fruit [1]. The origin of avocado is Meso America and it grows wild all over Latin America. The Spanish explorers took this fruit to Spain in 1601. Cultivated avocado was first reported in Mauritius in 1780, Florida in 1833, California in 1856 and Zanzibar in 1892, but the cultivation in these areas increased extensively during the 1900s [1,2]. Avocado is classified into three botanical groups; the tropical lowland West Indian race, the tropical highland (or cool subtropical) Mexican race and the tropical highland (or warm subtropical) Guatemalan race [3]. Selection and vegetative propagation of superior cultivars have occurred during the last 115 years [4]. Most modern vegetatively propagated 'subtropical' cultivars are partial hybrids between Mexican and Guatemalan races, selected either by chance or from superior seedlings [3].

Avocado fruit was first consumed by humans in Central America about 12,000 years ago [5]. Avocado consumption has been very low in many parts of the world outside the American continent. Recently the consumption has rapidly increased globally especially Europe [6] and Asia [7,8] and

avocado is now an important fruit in international trade [1]. The increased avocado consumption is due to the rising awareness of the people for eating healthy foods, the increased avocado popularity on social media and the improved accessibility of ready-to-eat delicious avocados [6,8,9]. The most interesting avocado healthy content is its monounsaturated fatty acids that are potential to decreasing the risk of coronary heart disease, cataracts, diabetes, benign prostatic hypertrophy, prostate and other cancers and macular degeneration [10–13]. In 2000/01 the United States domestic fresh avocado consumption was 246.1 million kg. The consumption rose by 352% to 1112.8 million kg in 2017/18 [14]. In 2000/01 the European avocado consumption reported to be 145 million kg [15], which increased by 251% to 510 million kg in 2017 [16]. In 2009/10 the per capita avocado consumption reported for European countries were 1.9 kg (France), 0.8 kg (United Kingdom), 0.8 kg (Switzerland) and 0.9 kg (Scandinavia) [15]. These values were lower than those for Mexico (9 kg), Israel (5 kg), Chile (4.5 kg) and United States (2 kg) [15]. In 2017 the per capita consumption for some leading European countries consumers were 2.44 kg (Norway), 2.31 kg (Denmark), 2.09 kg (Sweden), 2 kg (Netherlands), 1.7 kg (France) and 1.53 kg (United Kingdom) and 1.5 kg (Switzerland) [17].

Tanzanian economy depends on agriculture, which accounts for more than one-quarter of gross domestic products, provides 85% of exports, and employs about 65% of the work force [18]. The production is dominated by smallholder farmers [19]. Due to a number of production and marketing constraints facing smallholder farmers, market performance of high value crops appears to be low [19–21]. Delgado and Siamwalla [22] argued that some of the challenges facing African smallholders are a lack of markets, poor quality of produce and high transaction costs. Others include inadequate farmer skills and knowledge of production, and attacks of pests and pathogens [23]. The underlying causes of these challenges can be explained as institutional and natural factors as well as transportation related unsolved issues [19]. As a result, smallholder farmers become less competitive in the mainstream high value markets. Similar problems also affect production and marketing of potato [24], vegetables [19,20,25], citrus fruits [26–28] and banana [29].

In Tanzania, the prominent avocado producing areas are in the regions of Mbeya, Njombe, Songwe and Iringa in the southwest, as well as in Kilimanjaro, Arusha and Tanga in the northeast of the country. The other regions are Kigoma and Kagera in the northwest, and Morogoro in the east of Tanzania. The majority of the growers are smallholder farmers, who own a couple to hundreds of avocado trees around their homesteads and in distant farms. There are no consistent data from the Tanzanian government organizations on the total avocado production by the country. According to Mwakalinga [30]—based on data from the Tanzanian Ministry of Agriculture, Food Security and Cooperatives (MAFC)—Tanzania avocado production was 20,000 MT in 2010/11, and was projected to be 106,000 MT by 2019/20. However, Mwakalinga [30] alerted that MAFC data is inconsistent and reports less than the actual production. For instance, while MAFC reported that the country's avocado production was 25,000 MT in 2012/13, but separately the Rungwe district council estimated that it harvested 30,000 MT of avocado in the same year, which is greater than the total national production reported by MAFC in the same year [30]. Inconsistencies are also revealed in the recent data provided by the Tanzania National Bureau of Statistics (NBS) on avocado production in 2016/17. The data show that the total production was 19,449 MT in in 2016/17 [31], which is less than the amount noted by MAFC six years earlier. Likewise, the NBS data show that the Kilimanjaro region produced 71 MT in 2016/17 [31]. This amount is much lower than the quantity (473 MT) reported by the same organization for the same region in 2014/15 [32], two years earlier. It is worth noting that in Kilimanjaro there is Africado company, which produced more than 1000 MT of Hass avocado in 2016/17. The NBS data also noted as 0 MT of the avocado produce for the Tanga, Mbeya Njombe and Kigoma in 2014/15 [32], which is not realistic for these key avocado producing regions.

The local avocado cultivars, characterized with a short shelf life when ripe, are only sold in domestic markets. The commercial cultivars like 'Hass', 'Fuerte' and 'Waisal' are sold in the domestic markets, and also exported via the Rungwe Avocado Company (RAC; based in Mbeya region), Africado (based in Kilimanjaro region) and Kenyan middlemen. RAC and Africado are large-scale avocado producers and exporters based in Mbeya and Kilimanjaro, respectively. They support over 6000 smallholder avocado growers by providing seedling inputs, advice, workers during harvest and

transport of the avocados from the farms as well as purchasing their 'Hass' avocado fruits for export [33,34]. Tanzanian export of avocado rose from 86 (US$ 22,000) in 2011 [30] to 8371.15 MT (US$ 10.4 million) in 2017 [35]. The top export destinations in 2017 were Kenya (57%), France (15%), the Netherlands (15%) and the United Kingdom (5%) [35]. It is worth noting that the Tanzania avocado exports to Kenya are re-exported to Europe and Asia by Kenya. The Tanzania revenue authority (TRA) listed avocado among the top 10 export products from 2012 to 2016 [36].

Up to now, the available information about avocado growing and trade in Tanzania has mostly come from Africado, RAC or research on horticulture in general. For example, Match Maker Associates [36] conducted a horticultural study aimed at mapping the production of fruits and vegetables in Tanzania. Their research revealed that the horticultural industry in Tanzania was the fastest growing subsector within the agricultural sector with an annual average growth of about 9% to 12%. Furthermore, it was observed that in the fruit group, avocado was emerging as a main export produce, followed by mango. Recently, the policy brief by REPOA [37], based on desk research and field visits to northern Tanzania, explored the opportunities of avocado production in Tanzania. The study showed that the avocado value chain in Tanzania is hampered by a number of challenges throughout: from farming, processing and packaging to marketing. Research so far has offered little information about small-scale avocado production and local trade. Thus, the present study was undertaken to explore the avocado production by smallholder farmers in the southern highlands of Tanzania regarding the types of farms they own, types of avocado they grow, types of farming system they adopt, yield and economic gain from avocado crop, and the challenges the farmers face. The study also intended to explore the reliability of the local avocado trade as an income-earning opportunity to the locals, the capacity of the local people in running the business, its contribution to improving their lives and the constraints associated with this trade.

## 2. Materials and Methods

### *2.1. Study Locations and Sampling*

The study was carried out in the Njombe, Mbeya and Songwe regions of the southern highlands in Tanzania. A total of eight districts were selected based on their geographical location, accessibility and having many avocado farms (Figure 1).

**Figure 1.** Location map of the study sites.

Mbeya region lies between latitudes 7° S and 9°31′ S, and longitudes 32° E and 35° E. The region is situated at an elevation of 375–2981 m above sea level. It harbors an area of 37,700 km², and its population and population density were estimated to be 2,070,400 and 54.92 per km², respectively, in 2018 [38]. Its climate is mild, and generally warm and temperate with a temperature averaging 17.7 °C. The monthly average temperature is lowest in July, 14.6 °C, and highest in November, 20.1 °C. The region receives an average rainfall of 1023 mm. The minimum and maximum monthly average rainfall are 0 and 209 mm, occurring in August and January, respectively [39].

Njombe region is between 8°50′ S and 10°30′ S, and between 33°45′ E and 35°45′ E. Its area is 21,347 km², with an estimated population of 803,300 and population density of 37.63 people per km² in 2018 [38]. The climate is warm and temperate with an average temperature of 16 °C. The monthly average temperature is lowest in July, 12.8 °C, and highest in November, 18 °C. The rainfall averages at 1160 mm, with the lowest and highest monthly average rainfall being 1 (in August) and 258 mm (in March), respectively [40].

Songwe region lies between latitudes 7° S and 9°36′ S, and longitudes 32° E and 33°41′ E. It has an area of 22,600 km² with an estimated population of 1,202,400 and population density of 53.2 people per km² in 2018 [38]. Its climate is tropical with the average temperature of 20.8 °C. November is the hottest month with average temperature of 22.8 °C, whereas the coldest month is July with the average temperature of 18.3 °C. Its average rainfall is 1577 mm. The average monthly precipitation is lowest in August (3 mm) and highest in March (316 mm) [41].

The respondents were smallholder avocado farmers, local traders and key informants. The farmers and traders were visited in areas with many avocado farms. Key informants were selected based on their extensive knowledge of avocado production in the local area or by their affiliation to the local extension authorities. They were appointed as avocado growers' network leaders, district agriculture and livestock development officers and extension workers. Within each district, the aim was to interview a minimum of 30 respondents from each category of avocado farmers and traders. In some cases, the number of respondents was fewer than the minimum number set per district. The data were recorded from samples of 275 avocado farmers, 231 avocado traders and 16 key informants (Table 1).

**Table 1.** Information on number of farmers, traders and key informants interviewed in each district.

| Region | District | No. of Farmers | | | No. of the Traders | | | No of Key Informants |
|---|---|---|---|---|---|---|---|---|
| | | M | F | ST | M | F | ST | |
| Mbeya | Mbeya city | 22 | 14 | 36 | 4 | 28 | 32 | 1 |
| | Mbeya rural | 24 | 7 | 31 | 0 | 12 | 12 | 1 |
| | Rungwe | 30 | 10 | 40 | 23 | 9 | 32 | 1 |
| Songwe | Busokelo | 31 | 10 | 41 | 12 | 17 | 29 | 0 |
| | Mbozi | 22 | 10 | 32 | 0 | 34 | 34 | 1 |
| Njombe | Njombe urban | 24 | 2 | 26 | 3 | 28 | 31 | 8 |
| | Njombe rural | 20 | 9 | 29 | 10 | 20 | 30 | 0 |
| | Wanging'ombe | 31 | 9 | 40 | 11 | 20 | 31 | 4 |
| Total | | 204 | 71 | 275 | 63 | 168 | 231 | 16 |

F = female, M = male, ST = subtotal.

### *2.2. Method for Data Collection*

Field trips to the study sites were conducted from February to July 2017. Prior to study visits, a stakeholder meeting was organized to be held in Njombe region. It involved avocado growers' networks from the Njombe and Mbeya regions and a team of researchers. Having introduced the project objectives to the farmers and their leaders, a discussion was conducted on the avocado industry in southern highlands of Tanzania and opportunities associated with this industry. Farmers, individually, raised challenges they encounter in avocado production and marketing and discussions followed on how to mitigate them. Researchers used this opportunity to learn from farmers and collect data on the challenges they faced at the same time advising them accordingly. Key informants were chosen among the avocado growers' network leaders and were supplied with questionnaires. The leaders organized trips to visit avocado farmers and traders in the Njombe region. Two

individual farmers who were knowledgeable with many avocado-growing areas in the region were appointed to lead us to those areas. On arriving to a given village or street and being introduced to the local authority, we were given the local person to lead us to the households with avocado trees/farmers. We interviewed a few farmers per village or street, and we tried to skip some households in order to cover a large area in a village or street. The farmers were mainly interviewed on their farms and occasionally in selected common areas close to their farms. Once we were done with one village or street we drove to another one while skipping some villages or streets in between, in order to cover a large area of the district and diversifying the information we were collecting. For the case of traders, the local person from a given village or street took us to individual traders for the interview (if they were selling their fruits at their homesteads), or to the market (if there were established markets). On arriving to the market and meeting the market leader, either the leader or the same local person took us to individual traders for the interview. Again, if there were many traders, we tried to sample few of them in a given area while skipping others. In some areas there were a limited number of traders, and thus we interviewed all of them. All the traders were interviewed at their working places. The key informants who were district agriculture and livestock development officers or extension workers were interviewed in their respective offices. The same sampling methods applied to the Mbeya and Songwe region. A total of 33 and 21 villages/streets were visited in collecting data from avocado farmers and traders, respectively.

Apart from the focus group discussions described earlier and the survey for collecting information from avocado growers' networks and network leaders, the principal method used for data collection was face-to-face interviews based on semi-structured questionnaires. Three different questionnaires were prepared in English for collecting information from farmers, traders and key informants. The themes included in the farmers' questionnaire were knowledge on the grown avocado germplasm and the source for propagules, size and location of avocado farms, cropping system employed, yield, selling price for the avocado fruits and constraints associated with it. In the traders' questionnaire motives behind the trade, how to get the commodity, purchasing volume and loss estimates as well as constraints of the avocado trade were in focus. The key informants' questionnaire aimed at collecting information on the motives behind avocado growing in the district, the area under avocado cultivation, the adopted farming system, avocado germplasm grown, availability of extension services and future plans for the avocado crop in the district. Prior to use, we assessed its suitability for statistical analysis. In the field, the respondents were interviewed in Swahili, the Tanzanian national language and occasionally in tribal languages if they did not understand Swahili. In the latter case, local language translators were used to mediate communication between interviewers and respondents. The answers of the respondents were written down in English. The time taken for interviewing a farmer, a trader or a key informant was between 25 and 40 min, 15 and 35 min and 15 and 20 min, respectively. Some interesting photos taken in the field study are presented in Figure 2.


**Figure 2.** Some events associated with data collection during the field trip.

### *2.3. Data Analysis*

Open ended answers like statements on the problems encountered by farmers and traders were grouped according to themes. For instance, statements on the lack of a common market in some areas, lack of reliable markets, limited avocado customers, low avocado fruit price, price fluctuation, price dictation by clients or middlemen to farmers' produce and delayed payment by some customers were grouped as poor marketing conditions. The fruit yield estimates, the selling price of the produce, the purchasing volume and its price as well as associated volume loss that were given in different units were converted to the respective common unit. For example, the fruit yield estimates, purchasing volume and volume loss were given in the number of buckets, tins or bags, all of which were then converted to number of avocado fruits and later on to weight in kilograms. A bucket or a tin of avocado contains 35–60 avocado fruits depending on the fruit size and the size of the tin or bucket in a specific area. A bag of avocado fruits contains 5–10 buckets depending on the location and whether the bag was bought from farmers, middlemen or wholesalers. On average, one kilogram consists of 3–9 individual avocado fruits depending on the fruit size and the variety of avocado. Data from both the closed and open-ended answers were organized in Microsoft Excel. Most data on avocado production and local trade were then statistically analyzed with the Minitab® (version 18.1; State College, PA, United States) statistical software package [42]. Descriptive statistics and cross tabulation were employed in summarizing the data. The data that did not fulfill assumptions for normality were subjected to Chi-square tests for homogeneity of frequency distributions, while the ones that fulfilled those assumptions was subjected to a one-way analysis of variance (ANOVA). Logarithmic transformation was involved to reduce skewness of the data and make them assume the normal distribution before performing a one-way ANOVA. The results were then back transformed. Post-hoc tests were performed using the Tukey method to determine the differences in avocado fruit yield and its value-chain across categories of regions, districts and farmers. The statistical analysis regarding the challenges faced by the avocado farmers and the traders were limited to descriptive statistics. The frequency of occurrences of a given type of challenge among the respondents was counted and the percentage of the farmers or the traders that faced that specific challenge was calculated. Data recorded from the key informants on reasons behind avocado farming in districts, area under avocado cultivation in districts, cropping system and district plans for avocado crop were listed in a table.

## 3. Results and Discussion

### *3.1. Gender Pattern in Avocado Growing and Local Trade*

The majority of farmers interviewed (74%) were males (Figure 3). The highest (39%) and the lowest (8%) proportions of female avocado growers were obtained for Mbeya city and Njombe urban, respectively. The difference between the two districts might be due to the transformation of Njombe urban avocado farming from growing local avocado cultivar to only commercial cultivars, which needs high capital for purchasing quality propagules, fertilizers and agro-chemicals, of which many female farmers are unable to access.

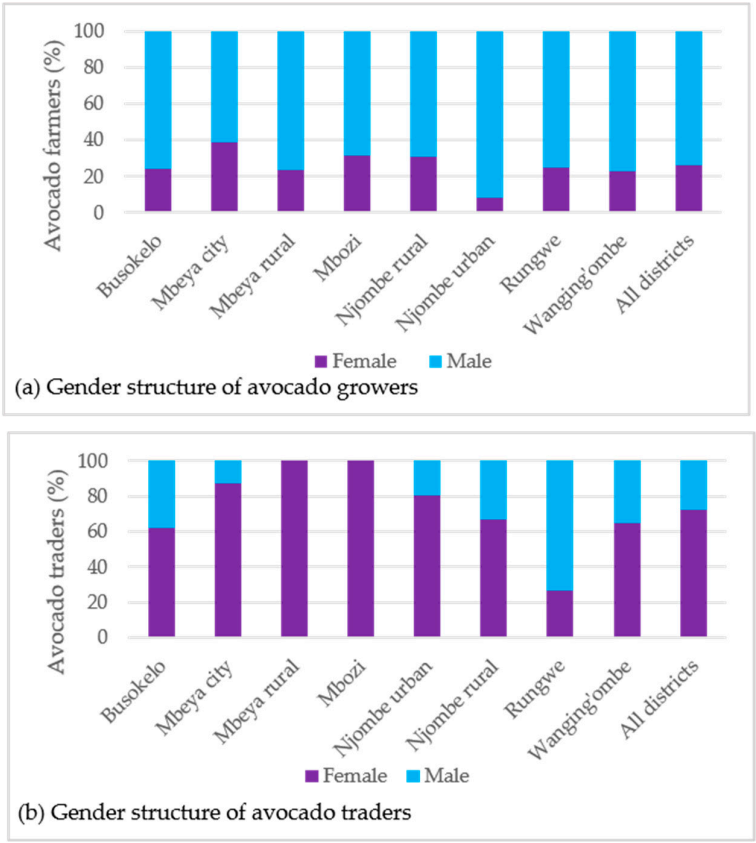


**Figure 3.** Gender pattern in avocado growing and local trade in eight districts of Tanzania.

The observed high proportion of males engaging in avocado farming in the present study is in agreement with Musimu [43], who reported males to constitute 70% of smallholder growers of common beans in Mbeya, Tanzania. Although the majority of farmers interviewed in the present study were males, it is worth noting that there is a substantial contribution by women in the avocado growing in Tanzania, especially in villages, as farming activities are carried out manually with the help of family members. Fischer et al. [44] observed that most vegetable nursery management in Tanzania is carried out by males and females in cooperation, except in the case of female-headed households.

Contrary to avocado growing, the avocado local business was dominated by females, who accounted for 72% of all traders across the districts (Figure 3). In each district, except Rungwe, the women represented at least 65% of the traders. The availability of avocado in a given area, the small capital-demanding nature of this trade, the possibility to run the business at home but also in some areas at the evening-operated markets, the desire to increase the family income for a better livelihood, are among the motives that drive many women to engage in avocado local trade. Oduol and Mithöfer [45] observed that in Kenya the female traders seemed to dominate avocado retailing trade in Kandara and Marani, especially in nearby markets due to the fact that they were more patient in sitting and waiting for customers than the males. Fischer et al. [44] reported that in Tanzania, marketing of leafy vegetables was also dominated by female small-scale traders.

### *3.2. Orchards and Types of Avocado Grown*

Three types of avocado orchards were noted in this study (Figure 4), with an average of 81% of all the farmers interviewed running intercropped avocado orchards, while the rest possessed either monocropped or both monocropped and intercropped orchards. The crops used in intercropping

with avocado varied with the climate and altitude of the areas, and involved fruit crops, vegetables, starchy food crops and other cash crops (Table A1, in the Appendix).

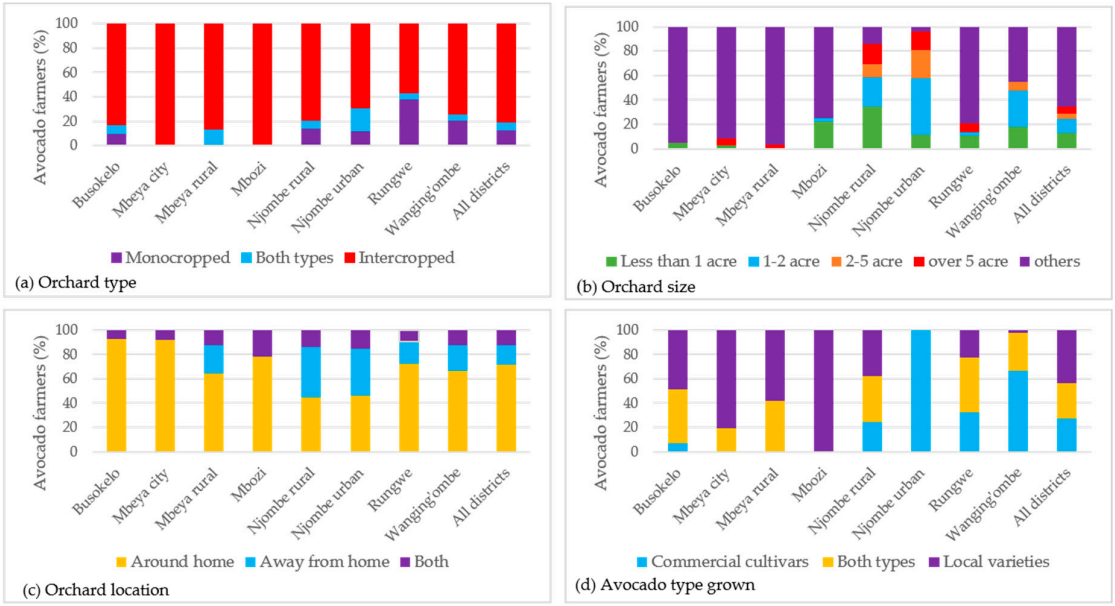


**Figure 4.** Type, size and location of avocado orchards and type of avocado grown.

The avocado farmers interviewed in the Mbozi and Mbeya city districts reported having only intercropped avocado orchards. While 87% of the farmers in Mbeya rural intercropped their avocado trees with other crops, 13% of the farmers in this district possessed both intercropped and monocropped orchards. In the other six districts, farmers at varying percentage possessed monocropped, intercropped or both types of orchards. Intercropping plays a great role in diversifying farmers' economy, assuring them to earn money throughout the year by selling a variety of crops during different periods (based on our interviews with farmers). Dube et al. [46] reported that most fruit growers in Tanzania intercrop their fruits with vegetables, maize and potatoes in order to earn additional income.

The size of the avocado orchards ranged from less than 1 to over 5 acres (Figure 4). Some farmers were unfamiliar to the actual orchard size and only reported the number of avocado trees, which ranged from 1 to 800 trees with an average of 41 avocado plants per farmer. In the Njombe rural and Mbozi districts 34% and 22% of the farmers, respectively, had less than 1-acre orchards. Likewise, in the Njombe urban and Wanging'ombe districts many farmers possessed orchards of 1 to 2 acres (46% and 30%, respectively), while in the Njombe rural and Njombe urban districts 17% and 15% of the farmers, respectively, had more than 5-acre orchards. A significant difference in the distribution of the orchard size across districts was observed ($\chi^2$ (28, $N$ = 273) = 175.35, $p$ = 0.001). Generally, as the orchard size increased, the number of farmers possessing them decreased. This might occur because many smallholder farmers have limited capital, which restricts them from acquiring more land for agricultural production. Mwambi et al. [47] reported that avocado production in Kenya is generally carried out in small farms of about two acres with the average of 13 avocado trees per household. The majority of the farmers in the present study reported that their orchards were located around their homestead. Others had orchards at a distant site or both around the homestead and at a distant site (Figure 4). Based on authors' assessment, having orchards around the home makes it easier for farmers to take care of the plants when the need arises. However, growing an avocado like this also means that domestic animals like goats and sheep roaming across the streets may destroy plants at an early growing stage, which causes conflicts between neighbors.

The interviewed farmers were categorized into three classes based on avocado types they grew (Figure 4). About 44% and 27% of the farmers were growing only local or commercial avocado

cultivars, respectively, whereas 29% were growing both types. A significant difference in the distribution of the avocado types across districts was observed ($X^2$ (14, $N$ = 273) = 199.89, $p$ = 0.001). More than a third of the farmers in Busokelo, Mbeya city, Mbeya rural and Njombe rural were growing only local avocado cultivar (Figure 4). In Wanging'ombe and Rungwe, farmers that grow the commercial cultivar accounted for 67% and 33%, respectively. Almost all farmers interviewed in the Mbozi district grow local cultivar whereas those in Njombe urban mostly grow commercial cultivars. The level of awareness among the farmers regarding the commercial avocado cultivars and their value on external markets determined the type of avocado to be grown. Mbozi district farmers were not familiar with commercial avocado cultivar. They had no contacts with neither agricultural research institutes nor the Rungwe avocado company. Njombe urban farmers were in general aware of commercial cultivars and their fruit value on external markets. In this district the Rungwe avocado company, motivated the farmers to shift to commercial avocado cultivars, supplied them with improved propagules and bought the fruits. Njombe urban also has a strong avocado farming network leadership that is active in organizing seminars on avocado farming and opportunities for external competitive markets. The commercial avocado cultivars grown were mainly 'Hass', 'Weisal' and 'Fuerte', and to a limited extent, 'Ettinger', 'Simmonds', 'Zutano', 'Nabal' and 'Booth 7'.

The results suggest that there is an increasing awareness among farmers in all districts, except the Mbozi district, that growing commercial cultivars may lead to a higher income than just growing the local cultivar. The local avocado cultivar undergoes spoilage within a couple of days after getting ripe (experience from traders and avocado consumers in Tanzania). While many avocado consumers in Tanzania prefer local varieties to commercial cultivars due to their superb taste, the demand on the global market for the latter ones is probably due to their longer shelf life. Mwambi et al. [47] reported that 'Hass' is the most preferred cultivar on the global avocado market due to being less susceptible to pathogens and pests, less vulnerable to physical damage and having a long shelf life.

The sources for commercial cultivar propagules were governmental research institutions, Agricultural Research Institute-Uyole (ARI-Uyole) and Sokoine University of Agriculture (SUA). Rungwe Avocado Company (RAC), the MANO plantation group, Technoserve and Menical chungwa, all from the private sector, also provided planting material. Other sources were individual farmers, farming groups and local nurseries. Regarding local cultivar, 97% of the farmers reported that they got propagules free of charge from friends, neighbors or relatives whereas the remaining farmers had purchased plants from ARI-Uyole, friends or neighbors.

Based on the information collected from the key informants, the motives behind avocado growing in the districts, the estimated area under avocado cultivation (based on 2015/2016 statistical data on crop production provided by district agriculture and livestock development officers), and number of horticulturists available for supporting farmers are given in Table A1 in the Appendix.

### *3.3. Fruit Yield Estimate and Avocado Value Chain*

At the regional level, the means of fruit yield ranged from 76 (Njombe) to 124 kg plant$^{-1}$ (Songwe; Table 2). In the different districts, the means ranged from 52 to 156 kg plant$^{-1}$, with the minimum and maximum values recorded in the Wanging'ombe and the Busokelo districts, respectively.

**Table 2.** Avocado fruit yield in southwestern Tanzania (2015/16).

| **A. Avocado Fruit Yield in Different Regions and Districts** | | | |
|---|---|---|---|
| **Region** | **Yield in kg Tree$^{-1}$ (mean)** | **District** | **Yield in kg Tree$^{-1}$ (mean)** |
| Mbeya | 119$^{a}$ | Mbeya city | 146$^{a}$ |
| | | Mbeya rural | 84$^{ab}$ |
| | | Rungwe | 97$^{ab}$ |
| | | Busokelo | 156$^{a}$ |
| Songwe | 124$^{ab}$ | Mbozi | 124$^{a}$ |
| Njombe | 76$^{b}$ | Njombe rural | 146$^{a}$ |
| | | Njombe urban | 71$^{ab}$ |
| | | Wanging'ombe | 52$^{b}$ |
| **B. Yield grouped according to the number of years the farmers have been engaged with avocado growing** | | | |

| Time (in years) | Yield in kg Tree$^{-1}$ (mean ± st. dev.) |
|---|---|
| 1–5 | 47$^{b}$ |
| 5–10 | 76$^{b}$ |
| 10–20 | 151$^{a}$ |
| >20 | 172$^{a}$ |

Means sharing the same letter in the superscripts within each column are not significantly different ($p > 0.05$) according to a Tukey test.

The districts could be grouped into three groups as per their fruit yield. The leading group consisted of the Mbeya city, Busokelo, Mbozi and Njombe rural districts with the yield ranging from 124 to 156 kg plant$^{-1}$. The intermediate group contained the Mbeya rural, Rungwe and Njombe urban districts with the yield ranging between 71 and 97 kg plant$^{-1}$. The Wanging'ombe district was the tail with a yield of 52 kg plant$^{-1}$. A statistically significant difference was found only between the leading and the tailing group. Thomas [48] investigated annual production of high and low-yielding 'Hass' avocado trees from 1991 to 1996. He found that the average yield from low-yielding and high-yielding trees ranged from 17 to 108 and from 156 to 327 kg tree$^{-1}$, respectively. Lovatt et al. [49] reported that the average annual yield for 3000 'Hass' avocado trees studied in California over 20 years ranged from 28 to more than 190 kg tree$^{-1}$. The yield estimates observed in our study were within the ranges reported in these studies. Considering years of avocado growing experience, the fruit yield ranged from 47 (for farmers with 1–5 years of experience) to 172 kg plant$^{-1}$ (for the farmers with over 20 years of experience; Table 2). These findings suggest that the yield increases with the number of years that the farmer has been engaged in avocado growing. Fruit yield also increased with the age of trees but in the case of this study majority of avocado seedlings (local avocado cultivars) were inherited from the grandparents.

Avocado fruits produced by smallholder farmers in Tanzania are traded locally in four different ways. The growers can sell the fruits directly to the consumers in the nearby markets within the growing area. This is the most profitable, although not the most reliable way since it cannot absorb the large volumes of avocado produced from the farmers in that area. Another way is to sell the produce directly to the wholesalers or venders, which come from within the same region or from a more distant region. This is a less profitable method although it is more reliable since a large volume of avocado produce can be sold within a short period. The third way is to sell avocado produce to the wholesalers and venders through middlemen. In this way, the farmers negotiate the price with the middlemen and in most cases the middlemen set low prices to earn more profit by selling the produce to wholesalers and venders at a prearranged price. The fourth way is to sell the assumed avocado produce while the fruits are still developing on the trees to wholesalers and venders through a signed convention. In this way a farmer gets payment in advance and is obliged to keep on managing the trees with the developing fruits until harvest.

The average price at which the farmers sold their produce to wholesalers, retailers or consumers in their areas varied significantly between regions and districts (Figure 5).

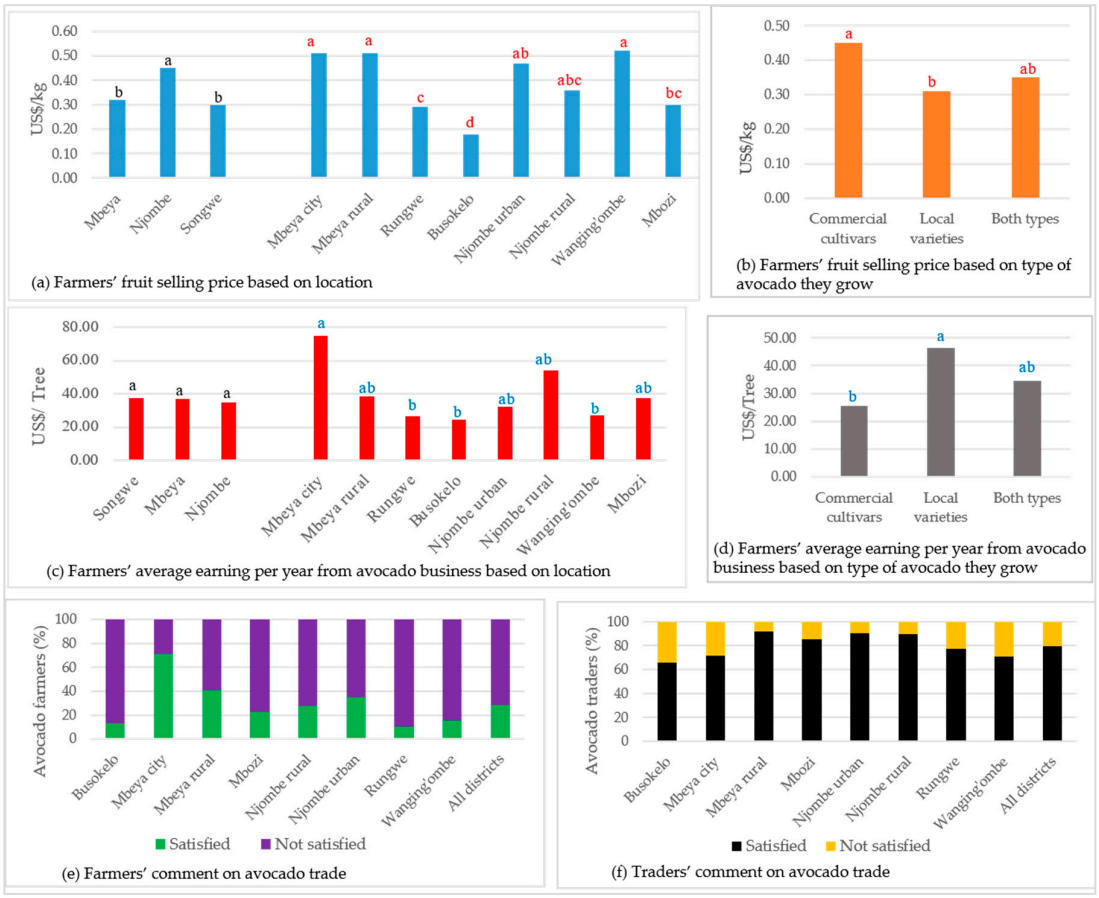


**Figure 5.** Selling price of avocado produce and comments from farmers and traders on the avocado business. Bars sharing the same letter with the same color in a Figure section are not significantly different ($p > 0.05$) according to a Tukey test.

The maximum and minimum prices were 0.45 and 0.30 US$ kg$^{-1}$ of fruits, and were recorded in the Njombe and Songwe regions, respectively. The farmers in the Busokelo district sold their produce at the lowest price (US$ 0.18), while those in Wanging'ombe sold their produce at the highest price (US$ 0.52). Within the Mbeya region, farmers in the Busokelo and Rungwe districts were selling their produce cheaper than farmers in Mbeya city and Mbeya rural. The lower prices could result from low demand in Busokelo and Rungwe as these districts are the highest avocado-producing areas in the Mbeya region. Furthermore, they are geographically isolated from the city centre and thus highly dependent on middlemen and wholesalers. These wholesalers purchase large volumes of avocado produce and distribute to avocado vendors within and outside the Mbeya region. A similar district is the Njombe rural district in the Njombe region whose farmers also indicated a lower selling price: US$ 0.36 kg$^{-1}$. Significant difference was observed between the prices received by the farmers growing only commercial cultivars (US$ 0.45 kg$^{-1}$) and those growing only local avocado varieties (US$ 0.30 kg$^{-1}$; Figure 5).

The farmers' average earnings from selling avocado produce per the fruiting tree throughout the year differed with location and type of avocado grown (Figure 5). Within the region, the average earnings ranged from US$ 34.70 (Njombe) to 37.59 (Songwe) per tree. At the district level, the Mbeya city avocado farmers earned the highest (US$ 74.88 per tree) whereas their Busokelo counterparts earned the least (US$ 24.38 per tree). The poor earnings of the Busokelo and Rungwe avocado growers are due to the lower price they get from wholesaling and the appreciably low avocado demand in these areas. Analysis of farmers' earnings based on type of avocado grown revealed that the farmers growing only local varieties earned higher (US$ 46.47 per tree) than those growing only commercial cultivars (US$ 25.63 per tree). This results from the fact that most of the local avocado

variety trees were very old and had a characteristic of growing huge, which gave them the potential to produce many fruits than their counterpart commercial varieties that were relatively young and had characteristic small tree architecture. However, from an economic point of view the commercial varieties have a big return per unit area of land compared to the local varieties especially when the farmers export their fruits directly. Taking an average of 41 avocado trees from the farmers that mentioned their number of avocado trees in this study, it can be estimated that the average earning to these farmers throughout the year is US$ 1050.83 or 1905.27 if growing only commercial cultivars or local varieties, respectively.

About 72% of the farmers across all districts were dissatisfied with the avocado prices (Figure 5). "It is hard to manage the trees and the cost of agricultural input is high", as a grower in Rungwe district described the situation. "The cost of production is high, we also hear that Njombe urban avocado growers sell their commercial fruits to Kenyans at TZS 1000 (US$ 0.44) $kg^{-1}$" another farmer in the Mbeya rural district argued. He sells his fruit at a much lower price, i.e., US$ 0.23 $kg^{-1}$. Shumeta [50] reported that Ethiopian avocado farmers were selling their fruits at lower prices, an average of US$ 0.05 $kg^{-1}$, in 2006. Omolo et al. [51] reported that in 2006 avocado farmers in Kenya were selling their fruit to consumers at US$ 0.02 per fruit (about US$ 0.10 $kg^{-1}$) whereas retailers were selling to urban consumers at US$ 0.05 per fruit (about US$ 0.25 $kg^{-1}$). According to DANE (The Colombian National Administrative Department of Statistics) [52] Colombian avocado growers were paid the average price of US$ 0.57 $kg^{-1}$ . Evans et al. [53] mentioned that the Florida avocado growers received an average price of US$ 0.99 $kg^{-1}$ in 2008, which is twice the maximum average price received by the Tanzania farmers in 2016. Dube et al. [46] reported that fruit farmers in Tanzania sell their produce mainly in the domestic market, which floods with the commodity during the harvest period, which in turn results in lower prices and a significant post-harvest loss. The same study also noted that many fruit farmers have no access to cold storage facilities.

The traders' purchasing capacity varied significantly between regions and districts (Table 3). The highest and lowest mean quantity of avocado fruits that the traders could purchase once in 7–10 days were 197 and 37 kg and were recorded for the Mbeya and Songwe regions, respectively. At the district level, the traders purchasing capacity ranged from 14 (Mbeya rural) to 349 kg (Busokelo). Generally, traders running their business in rural areas displayed a lower capacity as revealed by Mbeya rural and Njombe rural traders who reported 14 and 22 kg capacity, respectively. Although the Rungwe and Busokelo districts are rural areas, most of the traders interviewed were wholesalers from urban areas who provide avocado commodity to retailers in other districts. Interestingly, the traders purchasing ability varied significantly with gender, with the male traders reporting a higher capacity (212 kg) than their female counterpart (64 kg). The lower purchasing power of female avocado traders could be due to the fact that most of them have lower capital relative to their male counterparts and thus cannot afford buying larger avocado quantities. Oduol and Mithöfer [45] reported that the majority of avocado middlemen and wholesalers in Kenya were males.

**Table 3.** The estimated weight of avocado fruits purchased by traders and associated loss on selling.

| The Local Traders Purchasing Ability of Avocado Fruits at Once in kg* | | | | Percent Loss of Purchased Avocado Experienced by the Local Traders | | | |
|---|---|---|---|---|---|---|---|
| **Region** | **Mean** | **District** | **Mean** | **Region** | **Mean** | **District** | **Mean** |
| Mbeya | $197^{a}$ | Mbeya city | $185^{ab}$ | Mbeya | $21^{a}$ | Mbeya city | $25^{ab}$ |
| | | Mbeya rural | $14^{d}$ | | | Mbeya rural | $11^{bc}$ |
| | | Rungwe | $343^{a}$ | | | Rungwe | $19^{abc}$ |
| | | Busokelo | $349^{a}$ | | | Busokelo | $33^{a}$ |
| Songwe | $37^{b}$ | Mbozi | $37^{c}$ | Songwe | $12^{b}$ | Mbozi | $12^{c}$ |
| Njombe | $53^{b}$ | Njombe urban | $143^{b}$ | Njombe | $11^{b}$ | Njombe urban | $11^{c}$ |
| | | Njombe rural | $22^{cd}$ | | | Njombe rural | $9^{c}$ |
| | | Wanging'ombe | $42^{c}$ | | | Wanging'ombe | $12^{c}$ |

Means sharing the same letter in the superscripts within each column are not significantly different ($p > 0.05$) according to a Tukey test. * — the mean avocado fruit purchasing ability of males and females across the three regions was 212 and 64 kg, respectively.

The traders reported some loss of avocado fruits within their purchased volumes. The losses were caused by poor disease and pest management practices in the fields, poor harvesting practices, improper field handling, transportation, post-harvest diseases, over-ripening, spoilage and chilling injury resulted from improper storage temperatures, pest damage and physiological disorders. The mean percentage of loss varied significantly across regions and districts (Table 3). The minimum and maximum mean loss at the regional level was 11% and 21%, reported by Njombe and Mbeya traders, respectively. This difference might be attributed to variation in climate between the two regions as Mbeya is warmer than Njombe and thus Mbeya fruits are exposed to higher microbial and enzymatic activities, which speed up spoilage. At the district level, the Njombe rural traders reported the lowest avocado fruit loss (9%), whereas the Busokelo traders reported the highest mean fruit loss (33%). The traders with a higher purchasing capacity experienced a higher percent of loss. This is clear from the data obtained from the Busokelo, Mbeya city and Rungwe districts' traders, who purchased higher quantities but also had higher losses, i.e., 33%, 25% and 19%. It is harder to keep larger avocado quantities compared to smaller ones, given the fact that these traders did not seem to have cold storage facilities close to their working places. Most of these big amounts were also local avocado fruits that are easily spoiled. About 79% of all traders interviewed were pleased with their avocado business (Figure 5). "It helps me to meet the basic needs…avocado is a good fruit for home use", a trader in Mbeya city said when explaining her satisfaction with the avocado trade. In Ethiopia, a total of about 19% avocado loss has been reported to the traders due to mechanical injury, postharvest disease, postharvest insect and physiological disorders [54]. The World Economic Forum [55] reported that in Kenya, manual harvesting contributes to about 7% loss of harvested fruits and a total loss of 12%–18% in exports until the fruits arrive in Europe.

### *3.4. Challenges Encountered by Smallholder Avocado Growers and Local Traders*

About 98% of all the farmers involved in this study mentioned challenges in avocado growing. Of these, 36% were able to solve at least one of their challenges. All avocado traders interviewed indicated at least one challenge. The challenges facing avocado industry in Tanzania are given in Table 4.

**Table 4.** Challenges facing avocado production and local trade in Tanzania.

| Challenges Faced by the Farmers* | Number of Farmers that Reported the Challenge | % Age of Farmers that Reported the Challenge | Challenge Faced by the Traders | Number of Traders that Reported the Challenge | % Age of Traders that Reported the Challenge |
|---|---|---|---|---|---|
| Limited extension support services | 202 | 73 | Short fruit shelf life | 132 | 57 |
| Drought | 120 | 44 | Poor marketing conditions | 123 | 53 |
| Pests and diseases | 104 | 38 | Low quality and limited supply | 38 | 16 |
| Poor marketing conditions | 86 | 31 | Poor road networks and means of transportation | 40 | 17 |
| Restricted access to agricultural inputs | 51 | 19 | Low capital | 32 | 14 |
| Vandalism, theft and yield decline | 34 | 12 | Taxation | 31 | 13 |

*—Among 275 farmers interviewed, 270 (98%) of them faced at least one of these challenges, but only 100 (36%) of them were able to solve at least one of these challenges.

Limited extension support services were reported by 73% of the farmers. Only one extension officer was assigned by the government to each ward and some wards even lacked officers. Most of the extension workers have limited knowledge about avocado production and thus cannot guide the farmers in a proper way. Limited extension support service has been previously reported by Mutayoba and Ngaruko [19] to affect tomato production in Tanzania. They found that the number of extension agents assigned to assist farmers in each village in the Morogoro region was adequate but

the agents were however not that enthusiastic about their work. Daniel [56] assessed agricultural extension services in Tanzania and found that extension officers in general had poor working environments and had to tackle challenges like lacking a reliable means of transport to reach the farmers, limited financial support to carry out demonstrations and field experiments using new technologies, sub-optimal housing, lack of working facilities and low salaries. Shumeta [50] listed lack of extension support among major avocado-production constraints in Ethiopia. He noticed that there were no extension services to the surveyed avocado growing areas in the southwestern part of the country in 2006. The study by Gorge et al. [57] reported that 50% of the 400 respondent avocado farmers in western Kenya never sought extension services due to some reasons including unavailability of extension agents, long distance to find extension services and not needing the services. Sotto [58] reported that extension services to Philippine avocado growers were poor due to lacking avocado technical knowledge by extension agents who were mainly deployed for staple food crops.

Drought was reported by 44% of the farmers as being one of the limiting factors for avocado production in the research areas. More than 98% of the farmers depend solely on rainfalls for crop production. Drought was noticed by farmers to cause wilting of avocado flowers and tremendous fruit drop before maturity leading to a reduced crop yield. During the focus group discussion, a Njombe urban avocado grower said, "In 2016, the 'Hass' avocado trees produced plenty of flowers and we expected a good harvest. Unexpectedly, most of the flowers dropped, irrespective of frequent use of pesticides. What might be the reason behind?". Other farmers added "Avocado flowers drop heavily during dry season", "The fruits also drop while still young, at the size of chicken eggs". Drought has previously been reported as a challenge to the production of other crops in Tanzania, including citrus fruits [26,27], tomato [19] and potato [24]. In California droughts have severely affected avocado production in Riverside and San Diego counties to the extent that some avocado acres were stumped to minimize water consumption [59,60].

Pests and diseases such as *Phytophthora* root rot, anthracnose, bacterial blast, leaf rust, insect borers and mealybugs were reported by 38% of the farmers to affect avocado production by reducing fruit quality and crop yield. *Phytophthora* root rot causes yellowing and wilting of avocado leaves, dieback of small branches in the avocado tree top, decline in fruit production and death of affected trees. Avocado anthracnose rapidly affects fruit quality, with the injured areas of the fruit discoloring and producing a sour flavor. A bacterial blast causes fruit blemishes and cracks over most of the surface resulting into fruit drop. Insect borers cause fruit shedding, fruit distortion and dimpling as well as woody 'stones' where the fruit is stung. Evans et al. [53] reported that avocado pests and diseases could directly affect the avocado industry in forms of lost sales, property damage and increased orchard management costs. Ignoring the diseases and pests can lead to even a 50% decline in avocado production and its market value resulting to discouraging farmers to continue with production [53]. Anthracnose has been reported to affect avocado production and quality in New Zealand [61], Australia [62], Philippines [58] and Kenya [63]. The disease caused over 60% of losses in avocado production in Kenya during extended rains [63]. *Phytophthora* root rot has been reported to eliminate commercial avocado production in many areas in Latin America and is the major factor limiting production in Australia, California and South Africa [64].

Poor marketing conditions were reported by 31% of the farmers involved in this study. The challenges comprised a lack of reliable markets, low purchasing price dictated by the avocado traders or the middlemen, and the use of volume estimates (bags and buckets) as the common standard in avocado business transaction. Poor marketing conditions have also been highlighted by DPG (Development Partners Group Tanzania) [65] who reported that commercial avocado farmers in Tanzania were reluctant to selling their fruits to Rungwe avocado company that paid about US$ 0.14 $kg^{-1}$, while they could encash US$ 0.22 per fruit (about US$ 1.10 $kg^{-1}$) when selling directly to consumers in the local markets. Wholesaling the commercial avocados to Kenya middlemen, who offered US$ 0.44 per kg (based on the farmers interview in the present study), is advantageous to the farmers compared with selling their fruits to the Rungwe avocado company that pays about a quarter of the Kenyans' offer. However, analysis on the UN Comtrade data of the 2018 Tanzanian avocado

exports [66] shows that the average export values in US$/kg in the three leading destination countries were US$ 2.84 (France), 2.24 (Netherlands) and 2.91 (United Kingdom). This suggests that if the farmers develop the capacity to sell their commercial avocados directly to the export market, they will earn better prices than the ones they currently get from the export companies, Kenyan middlemen and even retailing in the domestic markets. Dube et al. [46] reported that farmers in Tanzania prefer to sell their fruits to intermediate buyers or middlemen as they can buy large fruit quantities within a short period of time. Selling small quantities directly to consumers would lead to larger waste. Mayala and Bamanyisa [67] noted that most horticultural crop producers in Tanzania sell their crops to wholesalers to save time and minimize transaction costs. Low prices and lack of market information have been reported as the major marketing problems faced by Kenyan avocado growers in the Trans-Nzoia district [51]. Shumeta [50] reported poor marketing conditions among Ethiopian avocado farmers where they received low prices to their produce due to the low avocado demand in their areas and were weak in negotiating the price due to their strong need for money, and the short fruit shelf life. In Colombia, low payments and unstable trading conditions have been reported to affect the small scale avocado farmers whose harvests are insufficient to cover the costs of taking their produce to other markets [68].

Restricted access to agricultural inputs was reported by 19% of the interviewed farmers, who mentioned limited access to pesticides, fertilizers and improved avocado propagules. It was more or less impossible to find these inputs in the Busokelo district due to the remoteness of the area. In other districts like Mbeya city and Njombe urban, the inputs were available but were expensive and many smallholder farmers could not afford to buy them. "Fertilizers are very expensive a ton of farm yard manure costs TZS 350,000 (US$ 153.71) I can't afford it" stated an avocado grower in Njombe urban. Restricted access to agricultural inputs has been reported by previous researchers to limit production of orange [26,27], tomato [19], beans [43] and potato [24] in Tanzania. Musimu [43] reported that the price of inorganic fertilizers and agro-chemicals in Tanzania ranged from US$ 27.23 to 30.74 per 50 kg bag and US$ 6.59 to 13.18 per liter, respectively, which was not affordable by many smallholder bean farmers and thus affected bean production and yield. Mutayoba and Ngaruko [19] noted that tomato farmers were always seeking alternative cheap methods of growing tomato instead of purchasing agro-inputs that they considered costly. Limited use agricultural input as a production constraint has also been reported among avocado producers in Kenya [45], Philippines [58] and Ethiopia [69]. Sotto [58] stated that the limited fertilizer application among Philippine avocado growers could be the reason for reduced crop yield and quality in the long run.

Among the avocado farmers, 12% reported orchard vandalism and yield decline to affect production. Grazing animals, mischief and fire outbreaks were associated with the destruction of young plants, fruits and entire avocado orchards, respectively. Reduction in yield was observed in the form of biennial fruit bearing and quite low fruit yield from some trees. Hoffman [70] reported yield decline due to a fire outbreak in California in 2008 where more than 600 avocado trees were destroyed.

About 57% of the avocado traders mentioned that the short shelf life of the local avocado cultivar affected their business. The fruit of local cultivar can be stored 5–7 days after ripening before losing firmness and then they undergo spoilage. Limited storability in combination with a high avocado supply and a low demand in some areas have caused many traders to experience heavy post-harvest losses. "I purchase two avocado bags (approximately 720 fruits). I can sell 1 to 1.5 bags of avocado whereas the remaining fruits undergo spoilage", said an avocado trader at Soweto market in Mbeya city. Another trader from Soko kuu in Njombe urban commented that "Meeting consumer preference and keeping up with spoilage are major challenges in my business. I try coping with both of them". Limited shelf life has been reported to affect avocado trade in Kenya [51] and Vietnam [71]. In Vietnam retailers preferred buying two butches per day, which consumed more time [71].

Among the traders, 53% stated that poor marketing conditions are a limitation to avocado local trade. This involved a lack of common, reliable markets in some areas and lack of information regarding external markets. Moreover, the retailers complained about high avocado purchasing prices set by middlemen and wholesalers and a lack of specific agreed upon selling prices. Avocado

fruit glut in the markets during peak season and unpaid debts were also among the concerns raised by traders. Poor marketing conditions contributed to high post-harvest wastes and low profitability to avocado traders in the study area.

About 17% of the local traders indicated that poor road networks and means of transportation affected avocado trade in their areas. This comprised of a shortage of roads to link avocado growing remote areas to market places and poor quality of seasonal roads, which become slippery during rainy seasons. The means of transport used were trucks like lorries and canters, which appeared to have high hire rates. The traders also employed electric tricycles (bajaji), motorcycles and bicycles when carrying avocado commodity to the markets. Poor transport infrastructure and inadequate means of transport contributed to high transport costs, fruit damages and significant post-harvest waste in the study area. Poor means of transport have been reported to cause about 5% avocado losses in Kenya [55]. Sotto [58] listed poor road networks and limited transportation facilities among the constraints of the avocado industry in the Philippines.

Low quality and a limited supply of avocado fruit were raised as factors affecting avocado trade by 16% of the interviewed traders. The quality related issues raised included unripe fruits that are picked prematurely, watery fruits and bruised fruits that easily decay. There was also a concern regarding fungi infested fruits that the customers spot at home after purchasing the fruit, and afterwards bring back to the respective traders. "It is difficult to meet consumer preferences, some clients say that the fruits are inferior" was a statement from one of the traders in Njombe urban. Due to a limited supply of avocado fruits, this trade was described as a seasonal business, which cannot be relied upon for the whole year. Avocado traders have adapted to this challenge by either seeking the commodity in other growing regions or shifting to other businesses during the offseason. Whiley [72] reported the poor fruit quality due to fruit rots as a major challenge of avocado business in Australia where it caused significant postharvest losses at the consumer level. Limited quantity has been reported to constrain avocado business in Vietnam during the off seasons where the price is higher [71]. In 2018, California restaurants suffered shortage of avocado fruits due to low supply, a situation, which forced some restaurants to look for an alternative ingredient for guacamole [73]. In July 2019, combination of increased avocado demand, limited supply and boarder tensions in the United States caused the price for the wholesale to jump to US$ 84.25 per 11.3 kg (US$ 7.42kg$^{-1}$) while the price at supermarkets was US$ 2.7 per fruit (about US$ 13.50 kg$^{-1}$) [74].

Taxation, waste removal and motorcycle overloading charges were indicated as challenges in the avocado trade by over one tenth of the traders interviewed in this study. The traders complained about the taxes they pay in the market and the waste removal charges. Wholesalers from other districts complained about local authorities of the Wanging'ombe district, which set higher taxation for them in order to give advantages to the wholesalers from their own district. This discouraged the outsiders from purchasing the Wanging'ombe avocado produce. There were also complaints about police charges related to overloaded motorcycles during transportation of avocado fruits.

## 4. Conclusion

The findings from the present study revealed that both local and commercial avocado cultivars were grown in Tanzania, with the local ones being grown by a majority of the avocado farmers. Most avocado farmers were men while more women than men worked as local traders. The Njombe urban farmers had accomplished replacing their local avocado trees with the commercial avocado cultivars, followed by the Wanging'ombe district growers, and thus had a good opportunity for securing competitive prices for their produce if they directed export to the global market. A number of challenges were found hindering the development of the avocado industry in Tanzania, which in turn affects the fruit yield and the value chain. Addressing these challenges at the national, regional, district and village levels is important for improving the livelihood of Tanzanian farmers growing this crop, given the fact that a good proportion of the country's population are employed in the agricultural sector and most of the reported challenges also affects the value chain of other crops. Moreover, from the gender composition observed in this study, it can be deduced that addressing

the reported challenges will contribute to raising the income opportunity among Tanzanian women since the females outnumber the males in engaging with the local avocado trade.

## 5. Limitations of this Research

Apart from being the first study detailing avocado production and marketing in Tanzania, this work had some limitations. The first limitation concerns the restricted number of samples representing avocado growers and traders in the Songwe region. In this region we only sampled the Mbozi district, leaving behind other districts in the same region where they also grow avocado. This was due to a shortage of time and a limited budget during the field work.

A lack of record keeping and standard units of measurement among avocado growers and traders featured other limitations. Farmers and traders relied upon their memory in offering information regarding avocado fruit yield, price, volume purchase and loss. This information was given in different units, most of them being trivial, e.g., fruit bag, tin and bucket. Working with these units involved conversion to standard units, which could be slightly inaccurate. Moreover, it was challenging for farmers and traders to recall the avocado prices in different marketing channels over the year.

In some areas, the farmers and the traders were reluctant in cooperating with and offering information to the researchers until they realized that there was financial incentive for providing reliable information. Sometimes, it was challenging to find the farmers in their homesteads since they were performing farming activities in distant farms. This leads to repeated visits to the homes of some farmers to collect the data. Likewise, collecting data from the traders in busy markets was challenging as the process was frequently interrupted with customers wanting to buy fruits. The researchers were patiently waiting for the traders to attend to the customers until they could proceed with data collection.

Another limitation of this study was the lack of recent data from the key informants regarding avocado production. This was due to the limited number of reports by the respective government ministry to account for crop production in Tanzania. For instance, we did not get the current data regarding the size of the area under avocado cultivation in all districts.

The final limitation of this study was the way we kept recording data on avocado yield. The farmer only gave the yield estimate for one of his or her trees based on memory recall. In order to accurately identify average yield, researchers have to study the fruit yield of several plants in specific areas for 3–5 years while continuously counting and recording the number and weight of harvested fruits.

**Author Contributions:** I.J., H.P.H, A.N., M.F., A.S.C. and R.O.O. designed the study; I.J., H.P.H. and A.N. collected data; I.J. analyzed data under the guidance of M.G. and R.O.O.; I.J. wrote the initial draft of the manuscript; H.F., H.P.H, A.N., M.F., A.S.C. and R.O.O. reviewed and edited the manuscript. R.O.O is the project PI.

**Funding:** This research was funded by Swedish International Development Cooperation Agency (Sida), grant number SIDA-Tz-UDSM-2015.

**Acknowledgments:** We would like to acknowledge the support of Dr. Jan-Erik Englund (Swedish University of Agricultural Sciences, SLU, Alnarp. Sweden) for assisting with questionnaire formatting and statistical analyses.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix

**Table A1.** Information provided by key informants on avocado farming in southwestern Tanzania.

| District | AUAC* | Reasons Behind Avocado Farming in the District | Crops Intercropped with Avocado** | District Plans for Avocado |
|---|---|---|---|---|
| Mbeya city[b] | 141 | - High internal and external market demand | Maize, cassava, potato, banana, pumpkin, cocoyam, bean, pea, amaranth, guava, pawpaw, | -Encourage each homestead to have at least four avocado plants |

| | | | | |
|---|---|---|---|---|
| | | - Favorable growing environment<br>- Being a cash crop | plum, mango, custard apple, coffee, sugarcane | -Use avocado trees for food, as ornamental and for environmental protection<br>-Link growers with internal and external traders<br>-Encourage the expansion of the avocado growing industry |
| Mbeya rural[c] | | - A habit or tradition of having avocado trees around a homestead<br>- High internal and external market demand<br>- Favorable growing environment | Maize, banana, sweet potato, cocoyam, pumpkin, bean, amaranth, tomato, lemon, orange, mango, plum, guava, pawpaw, coffee, sugarcane, pyrethrum, tobacco | -Facilitate conditions for growing more avocado for food and as a cash crop<br>-Create avocado farming groups and train them to improve their practical farming skills<br>-Train farm establishment |
| Rungwe[b] | 1508 | - Presence of RAC in Tukuyu, Rungwe | Maize, sweet potato, cassava, pumpkin, cocoyam, banana, soybean, bean, amaranth, olive, oil palm, lemon, pawpaw, mango, guava, pension, pineapple, strawberry, tea, coffee, cocoa, ginger, cardamom, sugarcane, sisal, | - Not much plans due to budget limitation<br>- There is little chance for expansion of avocado growing due to land shortage |
| Busokelo[a] | ina[d] | - Information not available | Banana, maize, sweet potato, cocoyam, bean, sunflower, groundnut African eggplant, lemon, oil palm, tea, coffee, cocoa, ginger, mango, guava, breadfruit, apple, orange, pawpaw, cardamom, lemongrass, dill, sugarcane, | - Information not available |
| Mbozi[b] | 1184.2 | - Being a cash and food crop<br>- As an alternative agricultural crop<br>- Source of revenue to district council | Maize, banana, cocoyam, sunflower, beans, mango, coffee, | - Shift from intercropping to monoculture<br>- Shift to commercial cultivars due to the high demand in international markets and high yield |
| Njombe urban[a] | 885 | - High market demand especially from Kenyan traders<br>- Influence from avocado growers' network that was formed in 2016 | Maize, cassava, cocoyam, pumpkin, lemon, apple, banana, sugarcane, sisal, | - Expand avocado growing area<br>- Provide up to date seminars for agricultural extension officers<br>- Establishing avocado oil processing |
| Njombe rural[a] | ina[d] | - Information not available | Maize, banana, cocoyam, pumpkin, sunflower, pawpaw, mango, guava, soursop, tea, coffee, sugarcane, | - Information not available |
| Wanging'ombe[b] | 838.7 | - Influence from RAC<br>- Influence from LIMA KWANZA Company<br>- High market demand | Maize, sweet potato, pumpkin, banana, bean, pea, sunflower, apple, custard apple, plum | - Expand avocado growing area: 1 acre for students, 1 acre for staff in secondary school, 10 ha for the district council<br>- Establish a platform for taking care of avocados<br>- Establish avocado oil processing |

*AUAC = area (ha) under avocado cultivation in 2015–2016; ** = the authors collected this data directly from avocado farms; [a] = no information on horticulturalists present; [b] = has only one horticulturalist; [c] = has two horticulturalists; [d] ina = information not available.

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