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A letter from Head of Editorial Board

Let us remain optimistic and look to the future

Prof. Dr. Dr. hc. mult. Angelika Ploeger, Head of the Editorial Board FoFJ

These days have been much different from those last years. For most of us, this means – no travel, no conferences and physical meetings, no visits from relatives and no brunch together in a big round. The last few weeks have been a major challenge for all of us, which still has to be overcome. In this way, we would like to thank all the people who are fighting against the spread of COVID-19 daily. Whether in health and care, in general care or indirectly by simply staying at home and thus reducing the risk of infection.

For me, these crises demonstrate the dependencies and social challenges we face in our different lifestyles around the world. It shows us e.g. that we in our German agricultural system do need people from eastern countries to help harvesting and planting and if the frontiers e.g. Rumania or Poland are closed, our farmers have to leave the plants to rotten on the fields and those foreign agricultural helpers are without a proper income for their families. This is just only one example and you might find such impressions and facts in your countries as well. All governments around the world have to adjust their regulations and laws for business and economies to their social systems, especially medical system. It shows clearly the importance of a well equipped and payable hospital or elderly home not to talk about those part of cities or regions in countries where poor people cannot follow the advice to keep distance or stay at home because they have to work to get food for the family.

Where ever in the world you are following our Journal, our team of Future of Food wishes you above all health and safety, but also a lot of strength and perseverance during this special and turbulent time. We hope that during the next weeks you will be able to draw new energy and to remember what matters: family, friendship and cohesion.

Let us remain optimistic and look to the future, in which we will certainly face many challenges together.

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Editorial

The lesson to be learned from the COVID 19 pandemic

Prof. Dr. Dr. h.c. mult. Hartmut Vogtmann, Honorary President of IFOAM (International Federation of Organic Agricultural Movements).

The COVID 19 pandemic was not the first serious health problem in the world caused by a virus and it is not going to be the last if the world community is not prepared to learn the lesson taught by this pandemic. Several reasons have been discussed for the heavy outbreaks in densely populated areas with heavy industries and therefore very high air pollution like Wuhan in China or the Lombardia in Italy. However, not only industrial areas but also densely populated cities like New York and others have also had a very heavy outbreak of COVID 19 infections and deaths.

One might come to the conclusion, that stress on our immune system is the reason. Stress caused by the pollution of our environment – air and water -, our food and our lifestyle - always faster, higher, cheaper – including our social behaviour. The main problem for this development is the present economic model of linear growth, which cannot function in the long run, because it is based on unlimited exploitation of nature and humans on our planet, especially in the less developed countries.

Since the publication about the science of circular economy by Pearce and Turner (1) the discussion about this new economic approach has been going on, but real actions on a worldwide scale are lacking. The politicians in nearly every single country are becoming concerned when the growth rate of the countries GDP is below 1,5 % or even before that. In the long run, the world community needs to adopt the principles of the circular economy to allow a living of humans on this planet with the resources available.

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However, this is not the only requirement. We also need to adopt another important principle: solidarity, which must be based on cooperation. Cooperation between humans and nature, as laid down in the Convention on Biodiversity (CBD) at the 1992 Conference on Sustainable Development in Rio de Janeiro (2). The underlying principle of economic and social welfare for the world's community is the conservation of nature, the sustainable use of its components and a fair share of the benefit of sustainable use.

However, today we learn that the CBD has great relevance also for human health. Arnulf Köhncke, head of the WWF Department of Species Protection, claims in his report about the „fight against zoonoses" (3) that an intact nature is a bulwark against zoonoses. The biologist Simone Sommer from the University of Ulm in Germany showed in her research studies the connection between the destruction of ecosystems with the loss of biodiversity and the appearance of infectious diseases (4). With pig and bird influenza there has been a clear connection with intensive animal husbandry in agriculture. However, in the case of COVID 19, it is different. Most zoonotic, that is between animals and humans transferable virus diseases, like Ebola, Sars and Mers are derived from wild animals. Destruction of our environment increases the infection rate of wild animals with potentially dangerous diseases for humans.

Therefore, to avoid another outbreak of a virus pandemic important demands are:

1. To stop the destruction of our environment and the loss of biodiversity. This means to keep all human activities in line with the goals of the CBD.

2. It is of utmost importance, that the illegal international trade with wild animals (obviously after drugs and weapons the third biggest illegal financial market!) is stopped immediately.

3. All supply chains have to be critically examined concerning their influence on environment and biodiversity and everybody needs to re-consider her/his consumption pattern, for all purchased goods, especially with a view to food. The option here is: short-chain supply - buy seasonally and regionally and thus strengthening the added value for the region.

However, the question is, if the world's community is prepared to seriously consider this and to work on the necessary social changes with a move from the winner-take-all-mentality to a solidarity economy. To bring this about we need wise political decisions supported by an independent critical and responsible science working with a transdisciplinary research approach, as demanded by Schmalzbauer and Visbek to reach the Social Development Goals formulated in the UN decision in 2015 (5).

For further information see:

(1) Pearce, D.W. and Turner, R.K. (1990): Economics of Natural Resources and the Environment. The John Hopkins University Press, Baltimore

(2) Convention on Biodiversity (1992): Report of the United Nations Conference on Environment and Development in Rio de Janeiro (1992); A/CONF. 151/26 (Vol. III)

(3) https://taz.de/Biologin-ueber-Pandemien/!5675740&s=Auslöser

(4)https://www.deutschlandfunk.de/kampf-gegen-zoonose-wenn-tiere-den-menschen-anstecken.724.de.html?dram:article_id414993

(5)Schmalzbauer, B. and Visbek, M. (2016): The Contribution of Science in Implementing the Social Development Goals. DKN Future Earth News, 04/2016, ISBN 978-3-9813068-5-9

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The impact of irrigation distribution uniformity and mulching soil on vegetative growth and yield of sweet fennel and squash plants

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irrigation, distribution uniformity, mulching, vegetative, yield, sweet fennel and squash.

Water shortage in agriculture is one of the adverse impacts of climate change which negatively affects global food production. Improving irrigation efficiency with mulching soil may optimize the condition by satisfing the water demand of food crops. Two experiments of the study were conducted at Dokki - Giza governorate, Egypt during winter and spring seasons of 2016/2017 and 2017/2018 under open field conditions. The study aimed to investigate the use of different number of PE laterals per growing bed (one irrigation line (OIL) and two irrigation line (TIL)) with different distances between the inline drippers (30 and 50 cm) on sweet fennel and squash to get the harmony distribution of irrigation in clay soil combined with mulching or with bare soil as the control. The field trails was performed using split plot design. The vegetative growth characteristics, yield parameters and N, P and K contents of sweet fennel and squash leaves were measured.

The obtained results indicated, that increasing number of laterals from 1 to 2 laterals /bed while decreasing the distance between drippers from 50 to 30 cm led to an increase in the vegetative characteristics, yield parameters and N, P, K contents of sweet fennel and squash plants as a results of enhancing the soil moisture availability and nutrient uptake. The treatment TIL 30 followed by TIL 50 recorded the highest results of sweet fennel and squash. Applying a black PE mulch into the soil led to an increase in soil temperature during winter and spring seasons and enhanced the vegetative growth, yield parameters and N, P, K contents of sweet fennel and squash plants compared to bare soil. Mulching soil lead to increase yield of sweet fennel and squash by 35 % compared to yield of bare soil. Results of the study conclude that applying two laterals per growing bed and mulching increase the yield of fennel and squash and it is a better option to mitigate adverse impacts of climate change.

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1. Introduction

Soil mulching around plants is a common agricultural practice which effectively increases the yield of butter lettuce and sweet fennel . The causes of yield increase of butter lettuce and sweet fennel cultivated under mulching were already discussed in the earlier study (Siwek et al., 2007). For decades, a common practice among the vegetable growers in Central Spain was the use of non-degradable plastic mulches in open fields, mainly for spring-summer season vegetable crops such as tomato, pepper, melon and watermelon for a variety of reasons (Green et al., 2003). Plastic mulches directly affect the microclimate around the plant by modifying the radiation budget of the surface and decreasing the soil water loss (Liakatas et al., 1986), resulting in more uniform soil moisture and a reduction in the amount of irrigation water, which is very important for summer crops. The plastic mulch application became a standard practice for most vegetable farmers who benefit from reduced evaporation, weed control, reduced fertilizer leaching and soil compaction, as well as elevated soil temperatures that promote earlier plant maturity. Hanada (1991) reported that mulching with appropriate materials had a number of effects, such as increased soil temperature, conserved soil moisture, controlled weeds, pests and diseases.

Efficient use of available fresh water by irrigation is becoming more important. Agronomic measures, such as varying tillage practices, mulching and anti-transparency can reduce the demand for irrigation water and improve irrigation water use efficiency (Farag et al., 2010). The mulch determines its energy-radiating behavior and its influence on the microclimate around the plant. Today, black and white mulches are common in the commercial production of vegetable crops around the world (Abdrabbo et al., 2010). Black PE mulch promote a relatively higher temperature at the soil surface, increase soil heat flux and, as a consequence, the minimum and maximum soil temperature are increased in comparison tobare soil treatments (Abdrabbo et al., 2009;EI-Dolify et al., 2016).

Christen et al., (2006) reported that drip irrigation is a method for applying water frequently and uniformly in small rates directly to the all plant root zones. Drip irrigation may not always be suitable for a particular agricultural system, regarding soil physical properties, establishment difficulties and cost considerations. In order to maximize plant production and minimize environmental impacts, good irrigation scheduling and management methods should be applied. Potential for improving water use efficiency depends on many factors related to the crop and soil system, water supply, the flexibility and efficiency of irrigation management system and the sensitivity of yield. By applying drip irrigation, severalplant stress, for example, water stress and aeration stress can be avoided.

Uniformity is a measure of how well water is distributed to the plants in a given field and is often expressed as a measure of variability (Howell, 2001). Mizyed and Kruse (2008) mentioned that irrigation uniformity is an important irrigation management factor of how evenly water is distributed across the field. No uniform distribution of irrigation water may create zones of over and/or under-irrigation, which can lead to yield reduction resulting from excessive nutrient leaching or plant water stress. Drip irrigation systems are very efficient in terms of water distribution and reduction of water losses. The uniformity is directly related to the pressure variation within the entire system and the variability of the emissions of each individual emitter. Several factors contribute to reduce the uniformity of water application such as excessive length of laterals, excessive pressure losses resulting from changes in elevation along the laterals, emitter clogging, and soil characteristics. Specifically, for drip irrigation in which the number of point sources of water (emitters) is limited, the uniformity of application can be compromised by the soil characteristics, leading to very intense water percolation during long irrigation events. Reduction in emitter spacing and also the use of double drip tapes placed closer to the crop rows may improve the uniformity of water and nutrient distribution along the beds while reducing the amount of water required. However, there is a lack of information about the effectiveness of this system for double-row crops (Zotarelli et al., 2009). Perennial crops may require one to five emitter laterals per plant row to adequately supply water needs depending on soil types, water emission device, size of plants and climate. Widely spaced planting establishments, like that of pecan trees, should have at least two lines, 2 to 3 m on either side of the row. More closely spaced perennial crops and vegetables, such as asparagus, grapes, sweet fennel and hops, may need only one lateral per row or bed (Lamm and Camp, 2007).

The current study aimed to enhance the agricultural practices for increasing the yield production of vegetables during different climate season conditions (winter and spring) and plant types (leafy and fruity) via investigations of the effect of irrigation distribution uniformity and mulching soil on sweet fennel and squash growth and yield.

2. Material and methods

Two field experiments were conducted in the experimental farm at the Central Laboratory for Agricultural Climate (CLAC), Agriculture Research Center (ARC), Dokki - Giza governorate, Egypt, during winter and summer seasons of 2016/2017 and 2017/2018. The soil of the experimental field is clay with pH 8.2, EC 2.4 dS m-1, organic matter 1.45%, CaCO3 13 % and total N of 20 meq / l.

Plant material

Sweet fennel (Apium graveolens var. rapeceum F1 hybrid) seeds were sown in polystyrene trays in the last week of October of both seasons while seedlings (after the fourth true leaf stage) were transplanted into soil on 20th and 22nd of November of the 2016 and 2017 seasons, respectively. Sweet fennel seedlings were cultivated in two rows (40 cm among rows) for each raised bed (80 cm wide) and the distance between the plants in-row was 30 cm.

Squash (Cucurbita pepo var Iskandrani) seeds were directly sown into the soil on 5th and 8th March of 2017 and 2018 after sweet fennel harvesting without soil preparation. Squash were placed in double rows. The final plant spacing was 50 cm in the row, 40 cm between the rows and 70 cm in between the beds.

Experimental Design and Treatments

Two factors combined under the study were investigated. The first factor was the impact of mulching: black polyethylene plastic mulch (BP Mulch) and bare soil (control). The second factor was four irrigation distribution patterns via different No. of emitters per bed (I and 2) with different distance between the drippers (30 and 50 cm) were used as followed to performed the treatments of the study.

1- One irrigation line per bed with 30 cm drippers distance (OIL30)
2- One irrigation line per bed with 50 cm drippers distance (OIL50)
3- Two irrigation line per bed with 30 cm drippers distance (TIL30)
4- Two irrigation line per bed with 50 cm drippers distance (TIL50)

The black plastic-film (120 cm in width and 125 µ thickness) was used to cover the experimental beds before planting the plants under study (sweet fennel and squash). The water requirements of both sweet fennel and squash during the cultivated seasons were calculated by CLAC and depended on measured Eto data while the water requirements were even for all irrigation distribution uniformity treatments. The experiments were laid out in Split Plot Design (SPD) in triplicates.

The vegetative and yield measurements

Three fennel and Squash plants for each treatment were taken at the end of growing seasons for measurements. The sweet fennel measurements were Fresh weight of Bulb (g/plant), Bulb length (cm), Bulb width (cm), Total fresh of leaves (g/plant), Total dry weight of leaves (g/plant), Leaf number/ plant and Plant length (cm).

The Squash measurements were Leaves numbers, Plant fresh weight (g), Plant dry weight (g), Total leaf area (m2), Yield (g/plant) and Fruit numbers.

Soil temperature and chemical analysis

Average soil temperature (°C) of different treatments were measured during the two cultivated seasons of both sweet fennel and squash by using a digital soil thermometer.

Mineral analyses of sweet fennel and squash leaves (N, P and K) were estimated at the harvest stage. Five samples of plant leaves from each treatment were dried at 70 °C in air forced oven for 48 h. Dried leaves were digested in H2SO4 according to the method described by A.O.A.C (2000). Total nitrogen was determined by Kjeldahl method according to the procedure described by FAO (1982) while P and K contents were estimated in the acid digested solution by colorimetric method (ammonium molybdate) using spec-

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trophotometer and flame photometer as described by Chapman and Pratt (1961).

Statistical Analysis

Data were statistically analysed using statistical analysis system (SAS) program (SAS, 2000). The differences among means for all traits were tested for significance at 0.05 alpha level according to Duncan tast.

3. Results

3.1. Effect of soil mulching on average soil temperature

The results given in Fig. (1) indicate that the mulching caused higher average soil temperature compared to bare soil treatment during winter and summer of sweet fennel and squash, respectively. The mulching of soil increased soil temperature in different rates regarding to air temperature .During the coldest days of January and First half of February in both seasons of sweet fennel and squash (2017 and 2018), the soil mulching recorded average soil temperature rates 0.4 oC higher than bare soil in winter season. The impact of increasing soil temperatures led to many advantages: enhancing the plant root growth, water and nutrients uptake due to better vegetative growth and

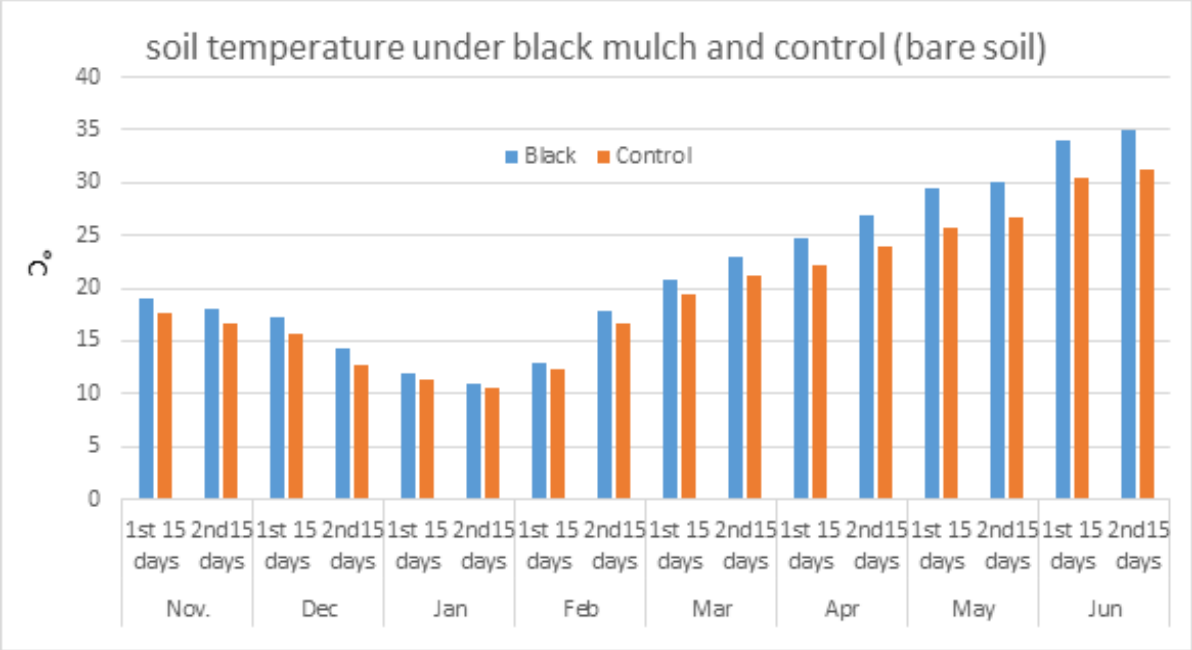

Fig 1. The effect of soil mulching on average soil temperature during the sweet fennel and squash seasons

yield. These results agreed with Abdrabbo et al. (2009) and Abdrabbo et al. (2013) who mentioned that soil temperature in control (bare soil) was the lowest soil temperature compared to black polyethylene mulch.

3.2. Effect of irrigation distribution uniformity and mulching soil on sweet fennel

3.2.1. Vegetative characteristics

The number of lateral treatments and distance between emitters had significant impacts on total fresh weight and dry weight (g/plant) of sweet fennel leaves while these impacts were absent in case of No. of leaves and plant height (cm) of sweet fennel as presented in Table (1). TIL 30 recorded the highest values of total fresh weight and dry weight of sweet fennel leaves followed by TIL 50, with significant difference, butno significant differences on No. of leaves as well as plant height. Conversely, the lowest vegetative characteristics of sweet fennel (total fresh weight and dry weight of leaves, No. of leaves and plant height) resulted from the OIL 30 treatment.

Regarding the mulch application, the obtained results of Table (1) indicated that the mulching application

had a superior effect on total fresh weight and dry weight of leaves, and plant height but not on No. of leaves of sweet fennel. Overall, the mulching application presented higher results compared to the bare soil treatment.

Table (1) illustrated number of laterals per bed, distance between emitters and mulching on vegetative characteristics of sweet fennel during the cultivated seasons. The interaction treatment TIL 30 combined

Table 1. Effect of irrigation distribution and mulching on vegetative characteristics of sweet fennel during the cultivated seasons.

	2017			2018		
	Soil mulch					
Irrigation	Total fresh weight of leaves (g/plant)					
	Control	Mulch	Mean	Control	Mulch	Mean
OIL 30	251.5 ^{cd}	323.5 ^{ab}	287.5 AB	235.4 ^{cde}	303.0 ^{b}	269.2 B
TIL 30	261.3 ^{cd}	359.0 ^{a}	310.1 A	246.3 ^{cd}	330.8 ^{a}	288.5 A
OIL 50	241.8 ^{d}	292.0 ^{bc}	266.9 B	217.3 ^{e}	261.0 ^{c}	239.1 C
TIL 50	258.8 ^{cd}	342.5 ^{a}	300.6 A	233.8 ^{de}	327.0 ^{ab}	280.4 AB
Mean	253.3 **B**	329.3 **A**		233.2 **B**	305.4 **A**	
	Total dry weight of leaves (g/plant)					
OIL 30	34.4 ^{b}	46.1 ^{a}	40.2 B	34.9 ^{c}	48.9 ^{a}	41.9 B
TIL 30	38.8 ^{b}	49.5 ^{a}	44.2 A	41.3 ^{b}	52.5 ^{a}	46.9 A
OIL 50	35.7 ^{b}	39.6 ^{b}	37.6 B	36.1 ^{bc}	41.0 ^{bc}	38.6 B
TIL 50	35.5 ^{b}	45.1 ^{a}	40.3 B	36.3 ^{bc}	48.6 ^{a}	42.5 B
Mean	36.1 **B**	45.1 **A**		37.1 **B**	47.7 **A**	
	No. of leaves / plant					
OIL 30	10.0 ^{a}	10.8 ^{a}	10.4 A	10.3 ^{a}	11.8 ^{a}	11.0 A
TIL 30	10.5 ^{a}	11.0 ^{a}	10.8 A	11.5 ^{a}	12.5 ^{a}	12.0 A
OIL 50	10.0 ^{a}	10.5 ^{a}	10.3 A	10.3 ^{a}	11.8 ^{a}	11.0 A
TIL 50	10.3 ^{a}	10.5 ^{a}	10.4 A	11.0 ^{a}	11.3 ^{a}	11.1 A
Mean	10.2 **A**	10.7 **A**		10.8 **B**	11.8 **A**	
	Plant height (cm)					
OIL 30	86.8 ^{a}	91.3 ^{a}	89.0 A	91.0 ^{a}	95.0 ^{a}	93.0 A
TIL 30	88.5 ^{a}	92.3 ^{a}	90.4 A	93.6 ^{a}	96.7 ^{a}	95.1 A
OIL 50	86.5 ^{a}	90.3 ^{a}	88.4 A	90.5 ^{a}	94.0 ^{a}	92.2 A
TIL 50	88.5 ^{a}	92.3 ^{a}	90.4 A	94.2 ^{a}	95.1 ^{a}	94.6 A
Mean	87.6 **B**	91.5 **A**		92.3 **B**	95.2 **A**	

* Similar letters indicate non-significant at 0.05 levels.
** Capital letters indicate the significant difference of each factor (P<0.05)
*** Small letters indicate the significant difference of interaction (P<0.05)

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with mulching soil gave the highest records of total fresh weight and dry weight of sweet fennel leaves while OIL 50 produced the lowest results. There were no significant differences among the different interaction treatments on No. of leaves and plant height of sweet fennel.

3.2.2. Yield parameters

Table (2) observed number of laterals per bed, distance between emitters and mulching on yield parameters of sweet fennel during the cultivated seasons. Referring to the number of laterals per bed and the distance between emitters effect, the treatment of TIL 30 yielded the highest records of fresh weight of bulb (g/ plant) and bulb width (cm) of sweet fennel while the highest result of bulb length (cm) was recorded with the use of OIL 30.

The mulching application had the highest values for fresh weight of bulb and bulb width while bare soil illustrated the highest bulb length of sweet fennel. These results could be explained by less competition between sweet fennel and weeds. Mulching soil minimized weed growth and offered better soil moisture and temperature conditions that encouraged more horizontal growth, while competition between the plant and weed encouraged more vertical growth Table (2) results indicated.

The interaction effects among the different treatments are illustrated in Table (2). The obtained results

Table 2. Effect of irrigation distribution and mulching on yield parameters of sweet fennel during the cultivated seasons.

	2017			2018		
	Soil mulch					
Irrigation	Fresh weight of Bulb (g/plant)					
	Control	Mulch	Mean	Control	Mulch	Mean
OIL 30	134.5 ^{c}	218.0 ^{b}	176.3 B	128.5 ^{e}	217.1 ^{b}	172.8 C
TIL 30	160.1 ^{c}	327.5 ^{a}	243.8 A	152.4 ^{cd}	312.3 ^{a}	232.3 A
OIL 50	151.0 ^{c}	217.8 ^{b}	184.4 B	139.9 ^{de}	205.5 ^{b}	172.7 C
TIL 50	188.0 ^{bc}	225.0 ^{b}	206.5 B	174.5 ^{c}	207.5 ^{b}	191.0 B
Mean	158.4 **B**	247.1 **A**		148.8 **B**	235.6 **A**	
	Bulb length (cm)					
OIL 30	11.3 a	10.9 a	11.1 A	10.9 a	10.7 a	10.8 A
TIL 30	11.0 a	10.1 a	10.6 AB	10.5 a	10.0 a	10.2 B
OIL 50	11.0 a	10.5 a	10.8 AB	10.4 a	10.3 a	10.3 AB
TIL 50	10.8 a	10.1 a	10.4 B	10.3 a	9.8 a	10.0 B
Mean	11.0 **A**	10.4 **B**		10.5 **A**	10.2 **A**	
	Bulb width (cm)					
OIL 30	10.3 ^{b}	11.6 ^{b}	10.9 B	9.6 ^{c}	10.9 ^{bc}	10.2 B
TIL 30	11.0 ^{b}	13.3 ^{a}	12.1 A	10.4 ^{bc}	12.2 ^{a}	11.3 A
OIL 50	10.5 ^{b}	11.8 ^{ab}	11.1 B	9.6 ^{c}	10.6 ^{bc}	10.1 B
TIL 50	11.3 ^{b}	11.8 ^{ab}	11.5 AB	10.2 ^{bc}	11.0 ^{ab}	10.6 AB

* Similar letters indicate non-significant at 0.05 levels.
** Capital letters indicate the significant difference of each factor (P<0.05)
*** Small letters indicate the significant difference of interaction (P<0.05)

showed that TIL 30 combined with mulching soil gave the highest results of fresh weight of bulb and bulb width while the lowest values came from OIL 50 combined with control (bare soil). There were no significant differences among the different interaction treatments regarding bulb length of sweet fennel.

3.2.3. N, P and K contents

The number of laterals per bed and distance between emitter treatments had a significant impact on N, P and K (%) contents of sweet fennel plants. The treatment TIL 30 presented the highest records of N, P and K contents of sweet fennel plants. Increasing the number of laterals, as well as shorter distance between emitters (30 cm) led to an increase in soil moisture uniformity and enhanced the nutrient uptake (Abdrabbo et al., 2005).

Table (3) illustrated the mulching soil impacts on N, P and K contents of sweet fennel; applying soil mulching led to improved N, P and K contents of sweet fennel resulting from enhanced soil moisture content, less competition and better soil temperature that encouragedw the N, P and K uptake. Mulching soil observed the highest N, P and K contents of sweet fennel compared to control.

Regarding the interaction effects among the number

Table 3. Effect of irrigation distribution and mulching on N, P and K (%) contents of sweet fennel plant during the cultivated seasons.

	2017			2018		
	Soil mulch					
Irrigation	N (%)					
	Control	Mulch	Mean	Control	Mulch	Mean
OIL 30	1.90 ^{c}	1.82 ^{d}	1.86 B	1.89 ^{b}	1.80 ^{c}	1.85 B
TIL 30	1.83 ^{d}	2.01 ^{a}	1.92 A	1.84 ^{bc}	2.01 ^{a}	1.93 A
OIL 50	1.80 ^{d}	1.98 ^{b}	1.89 B	1.80 ^{c}	1.96 ^{ab}	1.88 AB
TIL 50	1. 82 ^{d}	1.82 ^{d}	1.82 C	1.82 ^{bc}	1.83 ^{bc}	1.83 B
Mean	1.84 **B**	1.91 **A**		1.84 B	1.90 A	
	P (%)					
OIL 30	0.370 ^{cd}	0.423 ^{ab}	0.397 A	0.403 ^{a}	0.740 ^{a}	0.437 A
TIL 30	0.363 ^{cd}	0.443 ^{a}	0.403 A	0.427 ^{a}	0.480 ^{a}	0.453 A
OIL 580	0.377 ^{bcd}	0.410 ^{abc}	0.393 A	0.403 ^{a}	0.493 ^{a}	0.448 A
TIL 50	0.347 ^{d}	0.440 ^{a}	0.433 A	0.380 ^{a}	0.493 ^{a}	0.435 A
Mean	0.364 **B**	0.429 **A**		0.403 **B**	0.483 **A**	
	K (%)					
OIL 30	2.67 ^{bc}	3.52 ^{ab}	3.10 AB	2.75 ^{bc}	3.67 ^{ab}	3.21 B
TIL 30	3.06 ^{bc}	3.98 ^{a}	3.52 A	3.06 ^{bc}	4.21 ^{a}	3.63 A
OIL 50	2.60 ^{c}	3.06 ^{bc}	2.83 B	2.67 ^{c}	3.21 ^{bc}	2.94 B
TIL 50	2.52 ^{c}	3.36 ^{abc}	2.94 B	2.67 ^{c}	3.52 ^{abc}	3.10 B
Mean	2.71 **B**	3.48 **A**		2.79 **B**	3.65 **A**	

* Similar letters indicate non-significant at 0.05 levels.
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of laterals per bed, distance between emitters and mulching soil as shown in Table (3), the interaction treatment TIL 30 combined with mulch had the highest values of N, P and K contents of sweet fennel while the lowest results were recorded by OIL50 treatment combined with control.

3.3. Effect of irrigation distribution uniformity and mulching soil on squash

3.3.1. Vegetative characteristics

Table (4) present the effects of irrigation distribution and mulching on vegetative characteristics of squash during the cultivated seasons. The irrigation distribution uniformity had strong significant impacts on the vegetative characteristics of squash, while TIL 30 treatment gave the highest results of No. of leaves / plant, plant fresh weight (g), plant dry weight (g) and total leaf area (m2). The lowest vegetative characteristics were illustrated by OIL 50.Also, mulching had significant encouragement impacts on vegetative characteristics of squash compared to the control (bare soil). Mulching application recorded higher results of vege-

Table 4. Effect of irrigation distribution and mulching on vegetative characteristics of squash during the cultivated seasons.

	2017			2018		
	Soil mulch					
Irrigation	No. of leaves / plant					
	Control	Mulch	Mean	Control	Mulch	Mean
OIL 30	14.0 ^{bc}	16.7 ^{ab}	15.3 A	15.3 ^{bc}	18.7 ^{ab}	17.0 AB
TIL 30	12.7 ^{c}	17.7 ^{a}	15.2 A	16.0 ^{bc}	20.7 ^{a}	18.3 A
OIL 50	12.3 ^{c}	14.0 ^{bc}	13.2 C	15.0 ^{bc}	16.3 ^{bc}	15.7 B
TIL 50	11.0 ^{c}	16.3 ^{ab}	13.7 B	12.7 ^{c}	18.7 ^{ab}	15.7 B
Mean	12.5 **B**	16.2 **A**		14.8 **B**	18.6 **A**	
	Plant fresh weight(g)					
OIL 30	537.7 ^{cd}	1035.3 ^{ab}	786.5 B	501.2 ^{cd}	998.8 ^{a}	750.0 B
TIL 30	680.0 ^{c}	1225.0 ^{a}	952.5 A	644.0 ^{bc}	1127.7 ^{a}	885.9 A
OIL 50	392.3 ^{d}	672.0 ^{c}	532.2 C	359.6 ^{d}	644.0 ^{bc}	501.8 C
TIL 50	667.3 ^{c}	900.3 ^{b}	783.8 B	618.1 ^{c}	786.6 ^{b}	702.4 B
Mean	569.3 **B**	958.2 **A**		530.7 **B**	889.3 **A**	
	Plant dry weight (g)					
OIL 30	40.6 ^{e}	68.4 ^{b}	54.5 B	42.3 ^{bc}	71.6 ^{a}	56.9 B
TIL 30	54.0 ^{cd}	79.5 ^{a}	66.8 A	55.1 ^{b}	85.7 ^{a}	70.4 A
OIL 50	28.6 ^{f}	44.9 ^{de}	36.8 C	31.5 ^{c}	46.5 ^{bc}	39.0 C
TIL 50	52.7 ^{cd}	55.9 ^{c}	54.3 B	54.4 ^{b}	53.6 ^{b}	54.0 B
Mean	44.0 **B**	62.2 **A**		45.8 **B**	64.3 **A**	
	Total leaf area (m^2)					
OIL 30	2.61 ^{c}	3.73 ^{b}	3.17 B	2.59 ^{c}	3.72 ^{b}	3.16 B
TIL 30	2.95 ^{c}	4.67 ^{a}	3.81 A	2.97 ^{c}	4.86 ^{a}	3.92 A
OIL 50	1.49 ^{d}	2.72 ^{c}	2.10 D	1.52 ^{d}	2.85 ^{c}	2.18 D
TIL 50	2.33 ^{c}	2.96 ^{c}	2.64 C	2.38 ^{c}	3.00 ^{c}	2.69 C
Mean	2.34 **B**	3.52 **A**		2.37 **B**	3.61 **A**	

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tative characteristics compared to control as presented in Table (4).

Referring to the interaction effects on vegetative characteristics of squash, the obtained results of Table (4) indicated that the interaction treatment TIL 30 combined with mulching soil recorded the highest values of No. of leaves / plant, plant fresh weight (g), plant dry weight (g) and total leaf area (m2) while the lowest results of vegetative characteristics of squash were presented by OIL 50 combined with bare soil (control).

Table (4) shows the effects of irrigation distribution and mulching on vegetative characteristics of squash during the cultivated seasons. The irrigation distribution uniformity had a strong significant impact on the vegetative characteristics of squash while TIL 30 treatment gave the highest results of No. of leaves / plant, plant fresh weight (g), plant dry weight (g) and total leaf area (m2). The lowest vegetative characteristics were illustrated by OIL 50.

Referring the interaction effects on vegetative characteristics of squash, the obtained results of Table (4) indicated that the interaction treatment TIL 30 combined with mulching soil recorded the highest values of No. of leaves / plant, plant fresh weight (g), plant dry weight (g) and total leaf area (m2) while the lowest results of vegetative characteristics of squash presented by OIL 50 combined with bare soil (control).

3.3.2. Yield parameters

The number of laterals per bed and distance between emitter treatments had a significant impact on N, P and K (%) contents of squash. The treatment TIL 30 presented the highest records of N, P and K contents of sweet fennel plants. Increasing the number of lateral as well as shorter distance between emitters (30 cm) led to an increase in soil moisture uniformity and enhance the nutrients uptake (Abdrabbo et al., 2005).

Table (5) illustrated the mulching soil impacts on N, P and K contents of sweet fennel, applying soil mulching led to improve the N, P and K contents of sweet fennel as a result of enhancing the soil moisture content, less competition and better soil temperature that led to encourage the N, P and K uptake. Mulching soil observed the highest N, P and K contents of sweet fennel compared to control.

Table 5. Irrigation distribution and mulching on yield parameters of squash during the cultivated seasons.

	2017			2018		
	Soil mulch					
Irrigation	Total yield (g/plant)					
	Control	Mulch	Mean	Control	Mulch	Mean
OIL 30	543 ^{c}	1373 ^{a}	958 B	457 ^{d}	1276 ^{a}	867 B
TIL 30	1132 ^{b}	1250 ^{ab}	1191 A	1053 ^{bc}	1095 ^{abc}	1074 A
OIL 50	472 ^{c}	1250 ^{ab}	861 B	417 ^{d}	1211 ^{ab}	814 B
TIL 50	1123 ^{b}	1164 ^{b}	1144 A	997 ^{c}	1077 ^{bc}	1037 A
Mean	818 **B**	1259 **A**		731 **B**	1165 **A**	
	No. of fruits / plant					
OIL 30	14.3 ^{c}	37.3 ^{a}	25.8 B	14.3 ^{d}	35.3 ^{a}	24.8 C
TIL 30	29.0 ^{b}	31.3 ^{b}	30.2 A	28.7 ^{c}	29.3 ^{bc}	29.0 B
OIL 50	12.7 ^{c}	32.3 ^{b}	22.5 C	13.0 ^{d}	32.0 ^{b}	22.5 D
TIL 50	31.0 ^{b}	31.3 ^{b}	31.2 A	29.7 ^{bc}	32.0 ^{b}	30.8 A
Mean	21.8 **B**	33.1 **A**		21.4 **B**	32.2 **A**	

* Similar letters indicate non-significant at 0.05 levels.
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Regarding the interaction effects among the number of laterals per bed, distance between emitters and mulching soil as shown in Table (5), the interaction treatment TIL 30 combined with mulch had the highest values of N, P and K contents of sweet fennel while the lowest results recoded by OIL50 combined with control.

3.3.3. N, P and K (%) contents

Table (6) presents number of laterals per bed, distance between emitters and mulching effects on N, P and K (%) contents of squash leaves during the cultivated seasons. Enhancing the distribution uniformity of irrigation water led to improved nutrient uptakes while increasing the N, P and K contents of squash leaves. The treatment TIL 30 had the highest results of N, P and K (%) contents of squash leaves while the lowest values were recorded by OIL 50 treatment.

Similar results were observed in N, P, K contents of leaves under mulching in both squash and fennel. Mulching treatment had a significant effect on N, P and K contents of squash leaves compared to control treatment as shown in Table (6).

The results of interaction treatments effects on N, P and K contents of squash leaves Table (6) indicated that TIL 30 combined with mulching presented the highest N, P and K (%) contents of squash leaves while the lowest value was recorded by OIL 50 combined with bare soil treatment (control).

4. Discussion

Table 6. Irrigation distribution and mulching on N, P and K (%) contents of squash leaves during the cultivated seasons.

	2017			2018		
	Soil mulch					
Irrigation	N (%)					
	Control	Mulch	Mean	Control	Mulch	Mean
OIL 30	3.69 ^{c}	4.22 ^{ab}	3.95 A	3.52 ^{c}	4.33 ^{ab}	3.93 B
TIL 30	3.63 ^{c}	4.43 ^{a}	4.03 A	3.90 ^{bc}	4.58 ^{a}	4.24 A
OIL 50	3.74 ^{c}	4.07 ^{b}	3.90 A	3.71 ^{c}	4.35 ^{ab}	4.03 AB
TIL 50	3.48 ^{c}	4.41 ^{a}	3.95 A	3.50 ^{c}	4.19 ^{b}	3.84 B
Mean	3.64 **B**	4.28 **A**		3.66 **B**	4.36 **A**	
	P (%)					
OIL 30	0.32 ^{c}	0.42 ^{b}	0.37 B	0.31 ^{c}	0.40 ^{ab}	0.36 B
TIL 30	0.35 ^{c}	0.48 ^{a}	0.42 A	0.35 ^{bc}	0.46 ^{a}	0.40 A
OIL 50	0.31 ^{c}	0.37 ^{bc}	0.34 B	0.30 ^{c}	0.35 ^{bc}	0.32 B
TIL 50	0.31 ^{c}	0.40 ^{bc}	0.36 B	0.29 ^{c}	0.39 ^{b}	0.34 B
Mean	0.32 **B**	0.42 **A**		0.31 **B**	0.40 **A**	
	K (%)					
OIL 30	2.64 c	2.95 a	2.70 AB	2.56 b	3.12 a	2.84 AB
TIL 30	2.49 c	2.96 a	2.73 A	2.99 ab	3.12 a	3.05 A
OIL 50	2.42 c	2.71 b	2.57 B	2.55 b	2.69 b	2.62 B
TIL 50	2.33 c	2.82 ab	2.57 B	2.41 b	3.04 ab	2.72 B
Mean	2.43 B	2.86 A		2.63 B	2.99 A	

* Similar letters indicate non-significant at 0.05 levels.
** Capital letters indicate the significant difference of each factor (P<0.05)
*** Small letters indicate the significant difference of interaction (P<0.05)

The investigation on the effect of the number of laterals per bed and distance between emitters has less work than the assessment of water rationing, requirement of different crops and the development of modern irrigation methods. However it is important to regularize the optimal distribution of soil moisture at the same irrigation water amounts. In general, the proper number of laterals per bed and distance between emitters led to improvements in root and vegetative growth as a result of enhancing nutrient absorption (Abdrabbo et al., 2005). Improved vegetative growth resulted in increased quality of leafy vegetable crops while led to increase the yield of vegetable crops (Abdrabbo et al., 2005; Abdrabbo et al., 2015; Farag et al., 2016) .

The increase No. of laterals per bed from 1 to 2 with a decrease in the distances between drippers from 50 to 30 cm led to better moisture availability and improvements during the vegetative growth of sweet fennel and squash plants. TIL 30 followed by TIL 50 recorded the highest results of vegetative characteristics, yield parameters and N, P and K contents of both sweet fennel and squash. Sweet fennel and squash under TIL 30 gave a high yield and good quality.The results agreed to Mizyed and Kruse (2008) who reported that number of laterals per bed and distance between emitters are an important irrigation management factor, that determines how evenly water is distributed across the field. Improper number of laterals per bed and distance between emitters may create zones of over and/or under-irrigation, which can lead to yield reduction resulting from excessive nutrient leaching or plant water stress. Drip irrigation systems are very efficient in terms of water distribution and reduction of water losses. Christen et al., (2006) mentioned that to maximize plant production and minimize environmental impacts, good irrigation scheduling and management methods should be applied (Farag et al., 2016). Potentials for improving water use efficiency depends on many factors related to the crop and soil system, water supply, the flexibility and efficiency of irrigation management system and the sensitivity of yield. Sustained moisture supply by using proper water quantity with installed polyethylene mulch enhanced plant yield (Abdrabbo et al., 2014). The irrigation water supplied, irrespective of irrigation methods, was retained in the soil and efficiently distributed for crop growth (Farrag et al., 2016). The mulched soil causes indistinguishable irrigations levels by the crop .Higher water use efficiency is an integral part of mulch accompanied with drip irrigation (Abdrabbo et al., 2015)

The application of soil mulching required a lot attention in contrast to irrigation distribution uniformity. The positive effects of mulching cover many issues such as consistent soil moisture, conservation of irrigation water, soil temperature improvement, less weed competition, better nutrient uptake and better root and vegetative growth. Needless to mention many investigations assure the general positive impacts of soil mulching on the vegetable crops (Liakatas et al., 1986; Hanada 1991; Green et al., 2003; Hatami et al., 2012; Kumar and Lal, 2012).

Water resources and threats are specific to domestic conditions, as climate change consequences are manifested differently across local or regional levels. Development efforts for water resource management should involve proper analysis of dominating local conditions and concerns over development needs, and stakeholders should be involved in such progress (Chen and Davis, 2014).

Integrating both factors of number of laterals per growing bed as well as distance between emitters and mulching soil led to improved yields of sweet fennel and squash during different climate seasons conditions. The effect of both factors appeared during the coolest and warmest seasons for both of sweet fennel as leafy vegetable and squash as fruit vegetable crop.

5. Conclusion

Using two laterals per bed accompanied with 30 cm distance between emitters led to increased productivity of sweet fennel as well as squash during the two seasons. Moreover, using mulch led to improved productivity as well as water NPK percentages in both sweet fennel and squash leaves. The obtained results recommend the use two line emitters with 30 cm distance between emitters and black polyethylene mulch for producing both crops.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Analysis of household food expenditure patterns. A case of Shamva district Zimbabwe

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The study was designed to analyse the food expenditure patterns of smallholder farming households. Income and expenditure data were collected from 281 randomly sampled farming households in Shamva District. Descriptive statistics (mean and frequency) were used to analyse the income sources and main expenditure categories. The Ordinary Least Squares regression was used to model the determinants of household food expenditure. The results indicated cash crop, food crop and livestock sales as the major farm income sources. Remittances, wages, salaries and pensions were the major non-farm income sources. Statistics showed that 64% of the cash income was obtained from farm activities. Food expenditure accounted for over 60% of total expenditure. Household size ($p<0.05$), dependency ratio ($p<0.05$) and income (cash crop income, food crop income, livestock income and non-farm income) positively affected household food consumption. Age of household head ($p<0.01$) negatively affected household expenditure. The research results highlight the need for government to channel more resources towards improving smallholder agricultural productivity as the major household income source to foster demand-led agricultural growth and development in rural areas. By implication, this will similarly help to inform policy makers on appropriate instruments to improve income, food security and wellbeing of the farming households.

1. Introduction

Around 45% of the population in Sub-Sahara lives below the minimum poverty line of US$1 per day, with a greater disparity in income between urban and rural households. The current debates on human development are centred on reducing poverty and income inequality in rural areas (World Bank, 2008; Adekoya, 2014; Mignouna et al. 2015). The rural areas in sub-Sahara Africa are characterised by poverty, food insecurity, unemployment, inequality and a lack of important socio-economic services (Njimanted, 2006). Smallholders constitute two thirds of the poor population in rural areas (World Bank, 2008). Smallholder farmers depend on agriculture for their livelihoods and are subject to shocks and stresses such as climate change and volatility of food prices, making them vulnerable (O'Brien et al., 2008). The extent to which rural households are able to feed themselves depends on their own food production as well as abil-

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ity to purchase food using non-farm and farm income (Bhaipheti and Jacobs, 2009).

Proponents of agricultural-led economic growth argue that an increase in farm incomes results in an increase of expenditure on consumer goods and services, and thus can lead to indirect growth in non-farm incomes and employment (Browne et al., 2007; Baipethi and Jacobs, 2009). Therefore, for low income countries with large shares of the labour force living in rural areas, raising farm productivity has the potential to drive overall economic growth, reduce poverty (including food poverty) and improve social development and transformation (Baipethi and Jacobs, 2009). However, Jayne (1994) and Dorward et al. (2005), argue that services such as road infrastructure and markets are preconditions for agricultural development and unless such services are granted, the manufacturing industry would outcompete agriculture for labour. Though such pre-conditions for rural growth exist, an analysis of household main income sources provides a background on the necessary rural growth pathways that policy makers can take. Income levels give an indication of the welfare of the rural households.

Studies on expenditure patterns are regarded as key to monitor and explain inequalities and changes in material living standards, general welfare and food security. Food expenditure in the low-income communities constitutes the largest share in consumption. There are no international conventional standards to use for assessing vulnerability using share of food as a proxy for food security. However, Smith and Sumbadoro (2007) postulated that households who spent over 75% of their income on food are the most vulnerable and food insecure, as they can be affected by volatility of food prices. The duo also classified households spending 50-75% as having medium food insecurity, whereas those spending less than 50% as having low food insecurity. In the context of this study, where the smallholder farmers are regarded as low-income, understanding food expenditure patterns has strong implications on household food security.

Few recent studies exist on income and expenditure patterns of smallholder farmers and their dominance of the poor population (Umer and Asagowa, 2012; Biswajit and Sangeeta, 2015). A knowledge gap exists on relative contribution of agricultural income to total household income and how such income is used to meet household food needs. The objective of the study is therefore, to analyse the income and expenditure sources for smallholder farming households. The study also specifies the determinants of household food expenditure. This will assist in formulation of policy instruments to improve household income and food security of smallholder farming households.

1.1. Theoretical framework

Production theories recognise that smallholder farming households are both producers and consumers of goods and services. Consumption theory is based on the idea of diminishing marginal utility. Therefore, households choose the best alternative combination of commodities to maximise utility subject to constraints, i.e., time, resources and technology (Mignouna et al., 2015). The overall assumption of the household consumption and production theories is that farming households act rationally, to simultaneously decide on a bundle of commodities to produce and purchase that give them maximum satisfaction, subject to constraints. In rural households of low-income countries, where savings and investments are low, consumption expenditure can be used as a proxy for well-being (Seng, 2015; Adekoya, 2014). Previous work on household expenditure surveys have used five main components of expenditure: food, education, health, agricultural inputs and durable goods (Smith and Sumbandoro, 2007; Mignoun et al., 2015). For households in low income areas, food expenditure is the highest expenditure category (Browne et al., 2007; Sekhampu, 2012; Adekoya, 2014; Akaakohol and Aye, 2014; Seng, 2015) and the marginal food expenditure is expected to increase significantly with changes in income (Browne et al., 2007). Food expenditure in rural households is affected by income, price and other socio-economic and demographic characteristics (Meng et al., 2012).

According to Babatunde and Qaim (2010), both farm and non-farm income positively affect food expenditure. Akphan et al. (2013), used regression to analyse the determinants of food expenditure and realised that food expenditure contributed more than 40% of total expenditure for agro firm workers in Nigeria. A study by Adekoya (2014) in Nigeria found that income, age, sex and marital status were the major determinants of household expenditure. Seng (2015) analysed the determinants of household food consumption and

realised income, age of household head, household head's education, and household members <15years directly affect household food consumption. Similarly, Sekhampu (2012) and Sekhampu and Niyimbanira (2013) realised that income, age of household head, marital status, household size and education status of household head affected both food expenditure and household monthly expenditure in a South African Township. However, in the same study, married household heads had significantly lower food consumption than non-married ones. In a comparative study in Ghana and Nigeria Mignouna et al. (2015) found that apart from other factors already mentioned, farm size positively influenced household expenditure for yam growing farmers. Cuong (2015) used Ordinary Least Squares (OLS) to analyse impact of cash crop income on expenditure and found a positive effect on expenditure. Jodlowski (2016) analysed the impact of livestock on food consumption using Tobit regression and realised livestock income and household size positively affected food expenditure.

2. Materials and methods

2.1. Data Sources

The data for this study were collected in Shamva District in Mashonaland Central Province in Zimbabwe. A questionnaire was administered to 281 smallholder farming households selected using a multistage random sampling technique through face-to-face interviews. The questionnaire was pretested and administered by trained enumerators. The data collected include household characteristics, resources and levels of income and expenditure. Data were analysed using Statistical Package for Social Sciences (SPSS) and STATA. Specifically, descriptive statistics and the Ordinary Least Squares (OLS) regression were employed. Income and expenditure patterns were analysed using the mean, standard deviation and t-test. The OLS is used to predict a dependent variable, based on continuous and/or categorical independent variables, where the dependent variable takes a continuous form (Gujarati and Dawn, 2009). This model is suitable for assessing the factors determining food expenditure in the household.

2.2. The empirical model

The OLS regression model is specified as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + u$$

Where Y is the dependent variable, and this is given as monthly expenditure on food items.

X1... Xn are the independent or explanatory variables.

B0 is the intercept, β1... βk are the estimated coefficients of independent variables and u is the error term capturing the net effect of omitted factors. Since cross sectional data was used, the price was assumed to be constant across different households; therefore, unobserved characteristics were relegated to the error term. Cross sectional data usually have some degree of collinearity (Lauridsen and Mur, 2006). However, the Variance Inflation Factor (VIF) test was used to test for the presence of multicollinearity in which the data set had none. This was done to ensure more linear combinations of explanatory variables are screened, thereby ensuring the consistency of the expenditure function estimates. A VIF value of 1 shows the absence of collinearity and higher values of VIF implies higher collinearity. However, it is for values greater than 10 when one must remove such values in the model to ensure the model remains consistent (Liao and Richard, 2012).

2.2.1. The Dependant variable

The dependent variable is the household monthly food expenditure as estimated from a 30-day recall period. It summarises all the cash expenditure on food items consumed by the household.

2.2.2. Explanatory variables

Table 1 summarizes the demographical and socio-economic explanatory variables with their expected signs. The selection of variables likely to influence food expenditure was inspired by theory and previous studies such as Sekhampu (2012), Umeh and Asogwa (2012), and Akhpan (2013).

3. Results and discussion

3.1. Household income sources

Households' main sources of farm income were from cash crop sales, food crop sales, livestock sales and vegetable sales. The main sources of non-farm income

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Table 1. Demographic and socio-economic explanatory variables for household food expenditure

Description of Variable	Measurement	Expected sign
Sex of household head	1=Male, 0 = Female	+
Age of household head	Number of years	-
Marital status of household head	1 = Married, 0 = otherwise	+
Household size	Number of people	+
Dependant ratio	Ratio of household dependence	-
Non-farm income	Income in US$	+
Food Crop Sales	Income in US$	+
Cash crop sales	Income in US$	+
Livestock sales	Income in US$	+

Source: Authors computation 2019.

were remittances, salaries, wages, pension and trading. The mean annual income per household from main sources is summarised in Table 2. About 10% of the farmers' income was coming from remittances. Over 25% of the sample had income from cash crop sales with a mean household income of USD696. The results are consistent with findings from Ellis and Freeman (2004) highlighting that in low income communities of Uganda, Kenya, Tanzania and Malawi, few households participated in export-oriented cash crops. Literature, however, shows that cash crop production plays a significant role in reducing rural poverty and improving household welfare (Cuong, 2009; Akaakohol and Aye, 2014).

The annual income per capita showed that, on average, a household spent around USD0.5 per day per head, which is far below the World Bank poverty line. The statistics showed that 64% of the cash income was obtained from farm activities comprising mainly of crop and livestock sales. The non-farm income contributed 36% of the total income. This implies that though smallholder farmers rely more on agriculture for cash generation, other non-farm activities also play a significant role (Bowne et al., 2007; Babatunde and Qaim, 2010; Akaakohol and Aye, 2014; Adekoya, 2014).

Table 2. Mean annual household income in USD

Income Sources	Mean	Standard deviation
Cash crop income	696	1398
Food crop income	135	468
Livestock income	84	214
Trading (non-farm)	64	234
Wages + Salaries	118	450
Remittances	50	168
Total farm income	600	759
Total non-farm income	339	569
Total Income	939	936
Income per capita	189	265

Source: Authors computation 2019

3.2. Household expenditure patterns

The information in Table 3 shows the mean monthly expenditure in USD across different categories. Household expenditure for farming households could be split into five main categories. Food presented the

highest expenditure accounting for 62% of monthly income. Based on Smith and Sumbadoro (2007)'s classification of food security relative to food expenditure, smallholder farmers in Shamva District can be classified as medium food insecure. Such households are vulnerable to the volatility of food prices. The next biggest category is education, which accounted for 17% of total expenditure. Agricultural inputs accounted for about 13% of the monthly expenditure. Health and other expenses such as durable goods had similar spending of 4%. A typical household would spend about USD78 per month for all their household needs. The results are consistent with previous studies, which found food as the main expenditure category for low income farming households (Umeh and Asogwa, 2012; Mignouna et al., 2015; Seng, 2015).

3.3. Household food expenditure

3.3.1. Descriptive statistics

Additional descriptive statistics of household characteristics for sampled households are summarised in Table 4. Male-headed households dominated the sample and had a significantly higher mean food expenditure than female-headed households ($p<0.008$). Married households head also had a significantly higher expenditure on food than unmarried, with unmarried households only constituting 20% of the population. The unmarried household heads included widows, singles and separated. Over 50% of the households had household sizes of 4-7 people and food expenditure increased significantly with household size. The descriptive statistics for explanatory variables for income have already been discussed from Table 2. The aggregated non-farm income was used. However, farm income was disaggregated, and each component was fitted into the model.

3.3.2. Determinants of household food expenditure

The results of the regression model on determinants of household food expenditure are summarised in Table 5, The model was able to predict 40% of the variation ($R2= 0.400$). The results show that age of household head ($p<0.01$), household size ($p<0.05$), dependent ratio ($p<0.05$), non-farm income ($p<0.01$), cash crop income ($p<0.01$), food crop income ($p<0.01$) and livestock income ($p<0.001$) significantly influenced food expenditure. As age of household head increased food expenditure decreased. The results are consistent with Sekhampu (2012) and Hopper (2011) as older household heads are likely to spend less as they become more risk averse. Household size positively affected food expenditure. Similar findings were realised in Nigerian farm workers (Akphan, 2013). The bigger the household the greater the food demand, therefore, such household spend more on food consumption. Children and elderly people who constitute the dependants in the household usually require more expensive protein rich diets thus increasing food expenditure (Sekhampu, 2012). This applies to high income groups who do not use a large proportion of income on food expenditure. For low income level households, as the number of dependants increase, per capita income decreases resulting in lower food expenditure (Yimer, 2011). Contrary to Yimeh (2011), the results of this study indicate that dependant ratio significantly positively affected food expenditure.

As expected, income from all sources significantly affected food expenditure positively. For every USD1

Table 3. Average monthly household expenditure in USD

Expenditure category	Mean	Standard deviation
Food	49.72	31.75
Agricultural inputs	6.44	21.71
Education	13.21	26.82
Health	2.79	6.25
Durable goods	4.19	28.88
Total	78.18	78.16

Source: Authors computation 2019.

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Table 4. Descriptive statistics for household characteristics

Variable	Frequency (%) n=281	Mean Food Expenditure	Standard deviation	Sig.
Gender				0.008***
Male	81	51.59	33.62	
Female	19	38.77	30.97	
Marital Status				0.003***
Married	80	52.02	30.97	
Otherwise	20	38.22	32.94	
Age				0.382
< 30 years	7	36.22	21.13	
30-39years	21	50.90	31.90	
40-49years	27	59.79	35.17	
50-59years	21	47.53	29.63	
> 60 years	24	40.61	28.59	
Household Size				0.065*
2-3 people	15	32.13	26.74	
4-5people	32	47.67	27.20	
6-7people	27	55.19	35.04	
8-9people	13	52.44	35.29	
10 and above	13	57.06	30.91	
Dependent Ratio				0.815
0-<0.3	11	52.77	24.20	
0.3-<0.6	41	48.98	32.54	
0.6 and above	49	48.75	31.75	

Significant at: * 10%, **5 % and *** 1%
Source: Authors computation 2019

increase in non-farm income, food expenditure increased by USD0.01. Non-farm income significantly positively affected household food expenditure. In line with Babatunde and Qaim (2010), farming households rely on different sources of income for their food consumption. Cash crop income also positively significantly influenced food expenditure. An increase by USD1 in cash crop income resulted in USD0.01 increase in food expenditure. Cuong (2009) realised similar results in Vietnam with annual cash crops. Food crop income was also significantly influenced food expenditure positively, with each dollar increase in food crop income resulting in USD0.01 increase in food expenditure. Where there is a surplus in food crop production, the income gained from such crop sales can be used to supplement food. In line with Jodlowski et al. (2016), livestock income was found statistically significance and had a positive im-

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pact on household food expenditure. This explains the importance of livestock of ensuring food security for the smallholder farmers.

4. Conclusion and policy implications

The study was designed to analyse the income and expenditure patterns of farming households and the determinants of food expenditure. It was realised that households' main sources of farm income included cash crop sales, food crop sales and livestock sales. Main sources of non-farm income for households were wages and salaries, small businesses and remittances. Per capita income was far below the World Bank standard implying that the smallholder farmers are considered poor. Food expenditure dominated the household expenditure accounting for as much as 62% of total expenditure. Non-farm income, cash crop income, food crop income, livestock income, household size and dependant's ratio significantly influenced household food expenditure positively. However, age of household head negatively influenced household food expenditure. Considering farm income constituted over 64% of the total household income, agriculture growth can be one of the vehicles for economic development for the rural poor. It is important for the Government and Non-governmental sector to introduce programmes such as input subsidies to improve agricultural incomes. Using the relative proportion of income spent on food, the farming households can be classified as low income and medium food insecure. The results of this study further emphasise the impor-

Table 5. Determinants of household food expenditure

Variables	Coef.	Std. Err.	t	P>|t|	dy/dx
Sex	2.39	5.29	0.45	0.651	2.394
Age	-0.33	0.12	-2.78	0.006	-0.328
Marital status	0.48	4.57	0.11	0.916	0.484
Household size	1.56	0.52	2.90	0.004	1.560
Income from food crop sales	0.01	0.00	3.72	0.000	0.012
Income from cash crop sales	0.01	0.00	9.55	0.000	0.010
Income from livestock income	0.02	0.01	2.04	0.042	0.019
Total non-farm income	0.01	0.00	5.62	0.000	0.015
Dependents	12.85	7.47	1.72	0.087	12.853
constant	31.61	7.57	4.18	0.000	31.61

Number of obs = 281
F (9, 271) = 20.10
Prob > F = 0.0000
R-squared = 0.4004
Adj R-squared = 0.3804
Root MSE = 24.946

Predictive margins
Model VCE: OLS
Expression: Linear prediction, predict ()

	Margin	Delta-method Std. Err.	t	P>|t|
constant	49.322	1.488	33.14	0.000

Source: Authors computation 2019.

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tance of farm incomes to food expenditure implying that expenditure should be encouraged to promote demand-led agricultural growth and food security. Furthermore, non-farm employment opportunities should also be created to improve household incomes. Mechanisms to allow efficient flow of cash remittances should be allowed as they are an important source of income for farming households.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Household food wastage in Albania: causes, extent and implications

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Food waste (FW) is a very serious issue not only in ethical and social terms, but also given its economic and environmental impacts (cf. resource wastage and depletion). Recent data show that more than half of food wastage in the European Union is generated in households. FW is unfortunately not well addressed in Albania. For this reason, an exploratory online survey of 185 Albanians was carried out during August–November 2016 to analyse the causes, extent and implications of household food wastage in Albania. Most of the respondents' profile included a high education level, which may have affected the survey's outcomes. Nevertheless, results showed that awareness about negative impacts of FW is still low. Although FW seems high, few public initiatives and campaigns are put in place to tackle the issue. Therefore, it is time to move towards a comprehensive strategy that raises awareness on FW negative impacts in the Albanian society and increase knowledge on food purchase management, consumption habits and related food storage.

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1. Introduction

Food is lost or wasted throughout the food supply chain, from agricultural production down to final consumption (FAO, 2011; FAO, 2017; HLPE 2014). Different studies and reports show that between one third and half of the world food production is lost or wasted (FAO, 2011; Monier et al., 2011; Bio Intelligence Service, 2013; Institution of Mechanical Engineers-UK, 2013; Lipinski et al., 2013; Canali et al., 2014; HLPE, 2014; Berjan et al., 2018). According to recent data, 88 million tons of food are wasted throughout the whole food chain in one year in the European Union (EU), which is associated to an estimated cost of around 143 billion euros. Out of this, more than half of the waste (53%) is generated in households (Stenmarck et al., 2016). This leads to negative impacts throughout the food supply chain (Smil, 2004; Parfitt et al., 2010; BCFN, 2012; Kummu et al., 2012; Venkat, 2012; Chapagain and James, 2013; FAO, 2013; Grizetti et al., 2013; Hodges et al., 2010; Jereme et al., 2013; HLPE, 2014; FAO, 2015; OECD and FAO, 2015; FAO, 2017). Food waste is directly linked with environmental (energy, climate change, water, availability of resources), economic (resource efficiency, price volatility, consumption, waste management) and social (health, equality) impacts (Berjan el al., 2018).

Box 1. Definitions of key concepts.

- Food loss and waste (FLW) refers to a decrease, at all stages of the food chain from harvest to consumption in mass, of food that was originally intended for human consumption, regardless of the cause.
- Food losses (FL) refers to a decrease, at all stages of the food chain prior to the consumer level, in mass, of food that was originally intended for human consumption, regardless of the cause.
- Food waste (FW) refers to food appropriate for human consumption being discarded or left to spoil at consumer level – regardless of the cause.

Source: HLPE (2014:22)

In the last years, the European Union adopted a series of policies and strategies to address the food waste problem. The 'Roadmap to a Resource Efficient Europe' (EC, 2011) sets the aspirational goal of halving the disposal of edible food waste by 2020. The Circular Economy Package (EC, 2015), adopted by the European Commission in December 2015, is considered by many scholars as a concrete step to the transition towards a more circular economy in the EU (Brears, 2015) considering environmental, economic and social concerns. The package acknowledges the efforts and aligns with the Sustainable Development Goal (SDG) 12 "Ensure sustainable consumption and production patterns" in the framework of the 2030 Agenda for Sustainable Development (UN, 2015) – adopted by the United Nations' General Assembly on September 25th, 2015 - especially target 12.3 of the agenda that aims to halve per-capita food waste at the retail and consumer level, as well as to reduce food losses along production and supply chains. In the Mediterranean region, household food consumption accounts for 28% of the region's ecological footprint and a considerable part of the food footprint comes from waste or discarded food in the supply chain or in households (Galli et al., 2016), although the percentage varies among countries.

There is a considerable amount of food loss and waste along the whole food chain, including in households in the European countries (FAO, 2011; HLPE, 2014; Stenmarck et al., 2016). The seminal report of FAO on global food losses and waste (2011) shows that per capita food loss in Europe, including Albania, is 280-300 kg/year. Meanwhile, per capita food waste by European consumers is 95-115 kg/year. Nevertheless, percentages of food losses and waste change, not only along the food supply chain but also from one commodity group to another (Table 1). This leads to assume that food waste is also an issue in Albania. Nevertheless, few data are available on food loss and waste and few initiatives have been put in place to raise awareness about food wastage and its negative impact on social equity, resource efficiency and the environment. The only exception seems to be from Food Bank Albania, which was founded in 2015 and is the first national initiative to address the issue of food waste (FW) by organizing redistribution of surplus food (Food Bank Albania, 2016).

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Table 1. Estimated food losses and waste percentages for each commodity group in each step of the food supply chain for Europe

Step of the food supply chain Commodity group	Agricultural production (%)	Postharvest handling and storage (%)	Processing and packaging (%)	Distribution: Supermarket retail (%)	Consumption (%)
Cereals	2	4	0.5, 10	2	25
Roots and tubers	20	9	15	7	17
Oilseeds and pulses	10	1	5	1	4
Fruits and vegetables	20	5	2	10	19
Meat	3.1	0.7	5	4	11
Fish and seafood	9.4	0.5	6	9	11
Milk	3.5	0.5	1.2	0.5	7

Source: FAO (2011).

In medium- and high-income countries, such as Albania, food is to a significant extent wasted at the consumption stage (FAO, 2011; HLPE, 2014). There is a growing body of literature dealing with household food waste in different countries and regions (Evans, 2011; WRAP, 2011; Lebersorger and Schneider, 2011; Williams et al., 2012; Jereme et al., 2013; Quested et al., 2013; Graham-Rowe et al., 2014; Neff et al., 2015; Principato et al., 2015; Secondi et al. 2015; Mondéjar-Jiménez et al., 2016; Stenmarck et al., 2016; Bygrave et al., 2017; Canali et al., 2017; Principato, 2018; Schanes et al., 2018; Schmidt and Matthies, 2018). However South-East Europe (SSE) and in particular, Albania remain largely underserved (Kambo et al., 2017a; Kambo et al., 2017b; Osmani and Kambo, 2018). Therefore, in order to fill this literature gap, this paper analyses determinants, extent and implications of household food waste in Albania.

2. Materials and methods

2.1. Data collection and analysis

2.1.1. Survey

The paper investigates the results of a voluntary online survey carried out in Albania. Questionnaires previously used for similar research purposes - e.g. New South Wales (NSW) Environment Protection Authority (EPA), Australia (NSW-EPA, 2012); the University of Bologna, Italy (Last Minute Market, 2014) – were adapted to the Albanian context.

The survey was conducted through a self-administered questionnaire in Albanian, which was available online through the online survey website Survio (www.survio.com) between August – November 2016 (65 days in total). Participation was entirely voluntary and responses were analysed only in aggregate.

The multiple-choice questionnaire consisted of 25 one-option questions structured in six sections: (i) food purchase behaviour and household food expenditure estimation; (ii) knowledge of food labelling information; (iii) attitudes towards food waste and extent of household food waste; (iv) economic value of household food waste (HHFW); and (vi) willingness and information needs to reduce food waste. In the introductory part of the questionnaire the concept of FW was briefly introduced to inform the respondents about the topic and the purpose of the research (the following statement was included in the questionnaire: "For the purpose of the present survey, food waste is considered food that was purchased by the household for human consumption but was thrown away i.e. was not consumed") as well as the approximate time needed to complete survey (10-15 minutes).

Various communication channels were used to disseminate the survey, in particular social media (i.e. Facebook), emails and other communication channels (e.g. professional forums).

2.1.2. Data analysis

Quantitative data were analysed using descriptive statistics (e.g. means, max, min, percentages), and inputted into Microsoft Excel spreadsheets, to get a general picture of frequencies of variables. Besides descriptive statistics, the Chi-square test of contingency was performed to assess the associations between different respondents' characteristics and their answers. The Chi-square statistic is a non-parametric test designed to analyse group differences when the dependent variable is measured at a nominal level. It permits evaluation of both dichotomous independent variables, and of multiple group studies. The Chi-square is a significance statistic, and should be followed with a strength statistic (McHugh, 20113). The Pearson's contingency coefficient is the most common strength test used to test the data when a significant Chi-square result has been obtained. The Pearson's contingency coefficient was also calculated in SPSS Statistics 16 for Windows (IBM Corporation, Armonk, NY).The null hypothesis was that there is no relation between tested variables (e.g. gender, age, level of education) and respondents' answers regarding food behaviors and food wastage (e.g. frequency of food purchasing, use of shopping list, knowledge about food labelling, estimated amount of household food waste).

2.2. Socio-demographics of respondents

Convenience sampling method was applied becacuse of easy accessibility, availability at a given time and willingness to participate by members of the target population (Etikan et al. 2016).
Survio registered 295 visits out of which 203 questionnaires were completed for an overall 69% completion rate. Out of all completed questionnaires, 18 questionnaires were not considered for further data processing because there was missing data (unfinished questionnaires) and/or contradictory or bad quality data. Therefore, the size of the sample was 185 adult Albanians.

The sample is not gender-balanced, as a preponderant part of the respondents is composed by females (66.5% female) and predominantly young respondents (75.7% are less than 44 years old) with a high education level (around 80%). The territorial distribution is highly concentrated in Tirana, the capital city, which contains almost one third of the whole population of the Republic of Albania, but the remaining part is fairly distributed in the rest of the country (north and south, coastal and mountain areas). Half of the respondents are married with children while almost all the rest live with parents, with other people (not related) or are in a civil partnership. A very small part (2.2%) live alone, confirming that Albania still counts as not – one – person household. In fact, most of the respondents declare that their household is composed of at least 3 – 4 members (Table 2).

3. Results and discussion

3.1. Food purchase behaviour and household food expenditure estimation

The results of the survey showed that respondents buy food mostly in supermarkets (51.9%) and minimarkets (39.5%). Supermarkets are a rather new trend in the Albanian lifestyle, but it has significantly invested medium – high income households and highly educated Albanians. Generally, the reason is a certain variety in the products (not only agricultural but also processed ones), the proximity to other shopping centres (any non –food shop), parking space availability and lack of time during the working days. Minimarkets are very frequent and consist of small shops located in every inhabited area or quarter. This category also includes specialized shops such as bakeries, butcher' shops, dairy' shops, etc. Traditionally, minimarkets are the most common way for an average Albanian family to purchase basic goods because of the consolidated role these shops have gained throughout the years in the urban areas. A small number of respondents (4.3%) declared to buying their food in local markets. These results can be explained considering the high level of education of the sample and the high number of students and/or the youngsters. Morever, going to a local market or to a farm is more common for families with aging parents or for low-income households. Although there is a growing awareness among the new generation about the good food quality bought at a local market, it is still premature and thus not able to

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Table 2. Respondents' profile

Items		Frequency	Percentage (%)
Gender	Male	62	33.5
	Female	123	66.5
	Total	185	100
Age (years)	18-24	48	25.9
	25-34	58	31.4
	35-44	34	18.4
	45-54	30	16.2
	55 and over	15	8.1
	Total	185	100
Family status	Single person household	4	2.2
	Living with parents	23	12.4
	Partnered	25	13.5
	Married with children	93	50.3
	Shared household, non-related	38	20.5
	Other	2	1.1
	Total	185	100
Level of education	Primary school	0	0
	Secondary school	2	1.1
	Technical qualification	36	19.4
	University degree	118	63.8
	Higher degree (MSc, PhD)	29	15.7
	No formal schooling	0	0
	Total	185	100
Household composition (number of members)	1 to 3	70	38
	4 to 6	114	62
	7 to 10	0	0
	> 10	0	0
	Total	185	100
Occupation	In paid work (full time or part time)	101	54.6
	Student	43	23.3
	Unemployed and looking for work	23	12.4
	Home duties	12	6.5
	Retired/ Age pensioner	6	3.2
	Total	185	100

influence their lifestyle. Alternatively, going directly to the farm is more common for households that are directly linked with rural areas (having part of the family living there or relatives owning a farm) and this can explain the low percentage of respondents (4.3 %) buying food at a farm.

The frequency of food buying is rather high. Collected data revealed that 16.8% of the respondents declare they purchase food every day and 35.7% do it every two days. A considerable part of the sample (23.8%) do it every three days while a low percentage (15.1%) do it only once a week. This can be explained by a low attitude to budget planning, but also because of a need for fresh products. A small part of the sample (8.1%) purchases food once a month but it can be supposed

that these respondents are not regularly in charge of food planning for the household.

The survey shows that the monthly food budget of 36.8% for the respondents is concentrated in the range 7000 ALL (Albanian Lekë) – 14000 ALL (52–78 Euro; 1 Euro ≈ 136 ALL), while for 27.6% of respondents' food expenditures are in the range of 14000 ALL – 21000 ALL (78–104 Euro). A low number of the respondents declared they purchase food for less than 26 euro per month (9.2%), as they may not be the main person in charge of food planning.

The use of a shopping list is frequent, but not a consolidated practice. While 20% declare they use one at all the times, 18.4% claim that they do not make use of one. The remaining majority (61.6%) use one only sometimes. This is in line with the above observation that showed that most of the respondents have a high frequency of buying food. In this case, a shopping list may be marginal.
The attractiveness of special offers is quite high, with approximately one third (30.8%) claiming they always consider them and a significant 56.2% claiming frequent (sometimes) attention to offers. Only 13% say they are not at all attracted to offers. This can lead to food waste; thus, attention must be paid to expiry dates.

3.2. Knowledge of food labelling information

The questionnaire analysed whether there is any behavioural difference regarding "use by" and "best before" date labels. Interestingly, 72.4% show awareness that food should be consumed before "use by" date or otherwise discarded; while a lower percentage (25.9%) believe that the food may be eaten even after the "use by" date, as long as it is not damaged (Table 3). Notably, the "best before" label is not widespread in Albania and few information is given on it. Respondents have shown confusion between the two labels. About nine-tenths of respondents (88.6%), higher than that recorded in the case of "use by" date, believe that foods must be eaten or thrown away by "best before" date. This creates an opportunity to implement awareness campaigns that explain the meanings and the differences between the two date labels.

3.3. Attitudes towards food waste

The results of the survey show that food waste awareness is significantly low: 54.6% of the respondents do not consider food waste as an important problem, only 22.7% worry about it and try to reduce waste within their everyday routines. 9.2% understand the issue, but are not ready to change their behavior, 13.5% have worried in the past, but do not consider it a problem anymore. This trend may be explained by a low awareness about food waste impacts and by the consolidated habit to not waste food often seen in traditional societies . In fact, when asked how much food waste their household produces, 63.2% say a generic "reasonable quantity". Very few (5.4%) declare they produce much more than needed, while 13.5% are aware they produce more than needed. Moreover, 14.6% say they produce very little food waste and 3.2% say they produce almost none. The survey confirms that respondents' perception is that they generally do not generate much waste, driven by a low awareness about food waste.

The lack of awareness about the impact of food waste

Table 3. Knowledge of food date labels (n=185)

Statements	Which of the following do you think best describes what is meant by the "use by" date? (one answer was possible%)	Which of the following do you think best describes what is meant by the "best before" date? (one answer was possible%)
Foods must be eaten or thrown away by this date	134 (72.4)	164 (88.6)
Foods are still safe to eat after this date as long as they are not damaged, deteriorated or perished	48 (25.9)	5 (2.7)
Foods must be sold at a discount after this date	3 (1.6)	16 (8.6)

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is further confirmed by food waste behaviour. Household food waste is managed in different, not mutually exclusive, ways. An overwhelming majority (86.5%) of respondents say that sometimes they throw their food waste in the trash. Meanwhile, 60% of respondents also say they feed their pets with it. A very low percentage of respondents (10.3%) declare they give it to families in need, while 9.7% say they compost it in the garden.

Overall, the survey shows that only a 10.3% of the respondents throw out food more than twice a week, demonstrating a low/moderate propensity to waste food. It is wasted at least once a week for 53% of the respondents while 28.1% discard food less than once a week and 8.6% declare they never throw out food.

3.4. Extent of household food waste

Exploring the behaviour towards meals, a large percentage (48.1%) prepare their principal meal with fresh ingredients three to six times a week and 33.5% do it at least twice a week. A very small percentage (3.8%) prepares meals ex–novo more than 10 times a week, meaning many respondents do not cook every day and thus contribute towards waste production with a consequent important food waste production. However, these results might be affected by the survey's biasedness capturing mainly well-educated respondents from medium/high-income households.

Although with varying frequency, most households prepare meals from leftover foods. One third of the respondents claim to do it between seven to ten times a week and another third (29.7%) does it between three to six times a week. The remaining 4.9% declare they never do it. One aspect that reduces the extent of food waste is the Albanian habit to eat outside the home during the day (mostly fast food): 53% do it three to six times a week and 24.3% do it seven to ten times a week. Of the respondents, 20% eat outside the home at least twice a week and only 1.6% never do it. Nevertheless, these findings might be due to the biasedness of location, as a high share of the respondents are from urban areas, especially the capital city, Tirana. During the last years, semi-prepared or frozen foods (convenience foods) have become another alternative to cooking for urban medium/high-income Albanian households. The survey shows that 41.1% declare the use of convenience food in their meals three to six times a week and 27.6% do so seven to ten times a week. Another 9.2% prepare their meals with convenience foods more than ten times a week unlike 10.3% that never do. The use of semi-prepared or frozen food is prevalent and confirms the increasing popularity of convenience foods in Albania, a custom that 15 years ago was rare.

There are plenty of reasons why food is wasted in the Albanian household. The survey highlights bad food management by final consumers. For 76.2% of the respondents, food waste is generated because it has been left for a long time in the refrigerator and for 62.2% , food is thrown because it is stored improperly. For 61.6%, food is thrown because it does not have a good aspect, for 64.3%, it is done because it contains mould and for 50.8% because it no longer has a good flavour (Table 3). While many respondents selected the option "food is left in the fridge for too long time" or "food has expired", it is important to consider the root causes that led to this result and the subsequent food wastage. These reasons are mainly related to inappropriate meal planning and inadequate food storage. In light of these results, it is important to raise awareness among the population on ways to correctly save food and prepare adequate amounts of food for one meal in order to reduce food leftovers. It is essential to correctly manage meal planning and food buying behaviour since 36.8 % say that food waste is also due to incorrect planning and 47.6% say that the package sizes do not reflect their needs. In contrast, 53% say that food is thrown because it has remained from previous meals and a 42.2% say they can afford to throw out leftovers because the food in the household is abundant. The data further confirms the need to correctly manage meal and food preparation in the household. Complex labelling or label confusion by consumers, also accounts as a reason for food waste, although it is a relatively low reason(28.6%) compared to others. Nevertheless, with the growing trend of consuming semi – prepared and frozen food, the labelling issue must be clearly explained and an awareness-raising campaign should be implemented.

The quantity per week of thrown out food depends on the number of the members of each household. The survey's results show a worrying amount of food waste exemplified by the 36.8% of respondents who

throw out between 0.5 kg to 1 kg of food per week and 22.7% of respondents that reach between 1kg to 2 kg of food thrown out within a week (Table 5).

The amount of food waste differs according to food group (Table 6). Perishable and more frequently used products seem to be more sensible towards food waste. The survey shows that 50.8% say that more than 20% of purchased cereals and bakery products and 39.5% of purchased milk and its derivatives have been wasted. The large percentage of the wasted cereals and bakery products, as well as milk and dairy products is a serious environmental and economic problem considering the food groups' high consumption in Albania. The least wasted food group is roots and tubers, legumes and oilseeds, meat and meat products, and fish and seafood. Recent sources (e.g. Agroweb, 2016) also demonstrate that wastage of horticultural products is at alarming level in Albania. About 30-40 % of vegetables and fruits are wasted from production site to the market destination. That figure accounts for up to 50% of fruits and veggies lost from production to

Table 4. Main reasons contributing to household food wastage

Answer choices (multiple answers were possible)	**Frequency (%)**
Food expired	86 (46.5)
Food does not look good	114 (61.6)
Food has mold	119 (64.3)
Food does not have a good smell or taste	94 (50.8)
Labelling generates confusion	53 (28.6)
Food is left in the fridge for too long time	141 (76.2)
There was an error in meal planning / purchasing	68 (36.8)
Packaging was not the proper size	88 (47.6)
Poor cooking skills	88 (47.6)
Wrong preservation	115 (62.2)
Leftovers	98 (53.0)
Portions at home are too abundant	78 (42.2)
I did not like the food or ingredients	87 (47.0)

Table 5. Quantity of thrown food per week

Answer choices	**Ratio of respondents (%)**
I do not throw food	3.8
Less than 250 gr	19.5
Between 250 and 500 gr	14.6
Between 500 gr and 1 kg	36.8
Between 1 and 2 kg	22.7
More than 2 kg	2.7

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export and about 2% losses from supermarkets. Nevertheless, the survey results show that fruits and vegetables wastage at household level is rather low.

It is interesting to note that meat is moderately wasted considering the higher costs associated with it and that less than 20 years ago it was a coveted food and consumed with certain parsimony. This survey shows that the Albanian society has gone through important transformations concerning food consumption habits. The transition from a poor economy to an expanding one, has produced a quick and deep change that affected the food consumption habits of the country.

3.5. Economic value of household food waste

The outcomes of economic value of food waste show that 38.4% declare that they account for less than ≈ 5 Euro per month. More than a quarter (25.9%) of the respondents say that their food waste economic value is between 5 to 25 Euro per month,; this is huge considering that Albania has one of the lowest per capita incomes in Europe (5,253.6$ in 2018) (World Bank, 2019). A mere, but significant 6.5% of respondents say it is more than 50 Euro per month, a rather high economic burden for a considerable number of respondents, given the low average wages of Albanian households and their food budget. Albania has had a severe increase in income gap within its population in the last 25 years. Almost half a million of Albanians live under the national poverty line, which constitutes around 15% of the entire population living on no more than 1 Euro per day for personal expenses. In Albania, the average expenses on food are 58.5 % of the household budget. The lower the household budget is, the higher the income share necessary for daily food becomes, and this is increased up to 80% for more marginalized families (Food Bank Albania, 2016). The survey shows that there is economic loss in the household's budget in relation to food waste, so more careful food purchasing and meal planning will positively impact their lives.

3.6. Willingness and information needs to reduce food waste

According to 74.1% of respondents one way they would reduce food wastage is if taxes were to be implemented on food waste. Other respondents (36.8%) believe that food waste can be reduced if correct information is delivered about the negative impact on the environment and 29.2% believe that awareness to their own negative economic impact would reduce food waste. Overall, 35.7% of the respondents believe it could be done if packaging became more appropriate and a 33.5% if labelling would be clearer.

Table 6. Ratio of thrown food per group

Food waste ratio / Food groups	Less than 2%	3 to 5%	6 to 10%	11 to 20%	More than 20%
Cereals and bakery products (e.g. bread, rice, pasta)	9.2*	11.9	7.6	20.5	50.8
Roots and tubers (potatoes, etc.)	15.7	42.7	5.4	32.4	3.8
Legumes and oilseeds (e.g., peas, chickpeas, olives, sunflower)	12.4	11.4	55.7	19.5	1.1
Fruits	17.8	20	18.4	33.5	10.3
Vegetables	8.6	10.3	11.9	47.6	21.6
Meat and meat products	14.6	6.5	29.2	24.3	25.4
Fish and seafood	36.8	33	21.6	7.6	1.1
Milk and dairy products	8.6	25.4	15.1	11.4	39.5

*Figures in table refer to percentages of respondents and they sum up to 100% per food group.

Awareness on initiatives and campaigns by organizations that deal with food waste and its reduction is very important for 78.4% of respondents. Another 70.8% retain that food waste can be reduced if correct information is given on freshness of food and more than half believe that information on how to save food will also have a positive impact.

3.7. Discussion and suggestions for future actions

The relation between respondents' characteristics (e.g. gender, age) and their answers was assessed using Chi-Square Test of Contingency (Tables 7, 8).

The location of buying food, frequency of food shopping, attraction to special offers as well as the quantity of uneaten food thrown out by households were independent from the gender of respondents ($p \geq 0.05$). However, the frequency of throwing away leftovers or food, and the quantity of still consumable food thrown away in a week were dependent of respondents' gender ($p<0.05$). The economic value of food waste generated each month by households was highly dependent of gender ($p <0.01$) (Table 7). Both male and female respondents said that they feel attracted to special offers when they buy food. Regardless of respondents' gender, the quantity of uneaten food thrown away in a household is considered reasonable. Gender influenced the frequency of throwing away leftovers or foods that are no longer considered good i.e. female respondents answered they throw away this kind of food more often. However, this may be because women are responsible for cooking and meal preparation in Albanian households and not because of higher food wastage among women. Regarding the economic value of food waste generated each month by a household, in comparison to male respondents, most of the female respondents answered that this value is less than 5 EUR (700 Albanian Lek, ALL) or 5-25 EUR (700 -3500 ALL), so they tend to underestimate the value of wasted food.

Table 7. Chi-Square test of the influence of respondents' gender on food buying and throwing away food

Tested variables	Chi–square test statistics	p–value	Contingency coefficient
Where do you generally buy food?	0.979 ^{ns}	0.806	--
How often do you do food shopping?	8.054 ^{ns}	0.153	--
Do you feel attracted to the special offers when you buy food?	4.2463^{ns}	0.119	--
In general, how much of uneaten food your household usually throws away?	7.999 ^{ns}	0.091	--
How often you throw away leftovers or food that you consider not good?	8.677 *	0.033	0.212
Approximately, how much of still consumable food your household throws away in a week?	14.137 *	0.014	0.266
Please indicate the economic value of food waste generated each month by your household	13.539 **	0.003	0.261

ns = statistically not significant; * = statistically significant at $p <0.05$; ** = statistically significant at $p<0.01$. Gender: Male / Female.

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Results in Table 8 show that the age of respondents influence tested variables significantly. Young respondents answered that they buy food at supermarkets and minimarkets more often, whereby the same population buy food every day or once every two days, i.e. more frequently in comparison to older respondents, as expected. Most of the older respondents answered that they were not attracted to special food offers. Likewise, with age increase, there is a decrease in the quantity and frequency of throwing away food.

The results obtained are in line with the findings of Schanes et al. (2018) who states that food waste is "… a complex and multi-faceted issue that cannot be attributed to single variables" (p. 978). Kambo et al. (2017a) and Osmani and Kambo (2018) found that income, number of employed people in the household, age, and education level are all factors that determine the amount of food wastage in urban areas of Albania.

The results of the survey show that most of the respondents have low concerns regarding food waste and a large share of them are not ready to change food purchasing and consumption behaviour to reduce food wastage. This result is surprising taking into consideration the young age and high education of the sample. Different studies (e.g. von Kameke and Fischer, 2018) show that young people are more open to changing their behaviour in order to reduce food wastage. In Albanian urban areas, Kambo et al. (2017a) and Osmani and Kambo (2018) also found that there is a positive relation between age and the percentage of food wasted. The dominant profiles of wasters (Gaiani et al., 2018) that emerge from the study are the 'conscious-fussy type', who overemphasize food-related cosmetic and aesthetic features, and the 'conscious-forgetful type', that have bad food management and tend to forget food in the fridge or on shelves.

Table 8. Chi-Square test of the influence of age on the practices of food purchasing and food wastage at Albanian households

Tested variables	Chi–square Test Statistics	p–value	Contingency coefficient
Where do you generally buy food?	21.1772*	0.047	0.321
How often do you do food shopping?	127.895***	0.000	0.639
Do you feel attracted to the special offers when you buy food?	33.808***	0.000	0.393
In general, how much of uneaten food does your household usually throw away?	43.986***	0.000	0.438
How often do you throw away leftovers or food that you consider not good?	42.588***	0.000	0.433
Approximately, how much edible food does your household throw away in a week?	95.533***	0.000	0.584
Please indicate the economic value of food waste generated each month by your household	65.391***	0.000	0.511

* = statistically significant at $p<0.05$; ** = statistically significant at $p<0.01$; *** = statistically significant at $p<0.001$.
Age: 18-24 years old (first group), 25-34 years old (second group), 35-44 years old (third group), 45-54 years old (forth group), ≥ 55 years old (fifth group).

According to the survey, food waste is prevalent in Albania and the most wasted foods are bakery and dairy products. This result differs from the findings of Kambo et al. (2017a) that "The largest contributors to food waste are easily perishable items like fresh fruit and vegetables, followed by bakery products, dairy products and eggs" (p. 496). They add that each Albanian urban household wastes on average 22.4 percent of the purchased food. However, Silvennoinen et al. (2014) found that vegetables and milk products are the most discarded foodstuffs in Finnish households. This shows that the amount, as well as the composition of household food waste is dependent on context.

Food wastage has negative impacts on the food expenditures of Albanians. For more than a quarter of the respondents, the economic value of food waste generated each month is more than 25 EUR. Likewise, Kambo et al. (2017a) estimated the average value of food waste per month and per urban household at 19.4 EUR. However, the present survey shows that the estimate of the value of food waste depends on gender and age of respondents.

Moreover, more than half of the interviewees declared that they throw at least 500 g of food per week. Anyway, the amount of food waste might be affected by the fact that most of the respondents live in cities (especially the capital city, Tirana); indeed, some scholars (e.g. Samangooei et al., 2016) argue that people living in cities have become disconnected with food production, leading to increased food waste. In a survey conducted by Kambo et al. (2017a) in urban areas of Albania, the average weight of wasted food per week by each urban household amounted to 1.042 kg.

Food waste is a serious issue that undermines food security and food system sustainability in the Mediterranean region (Berjan et al., 2018; Capone et al., 2016; El Bilali, 2018), Albania included. The results of the present survey are in line with those obtained in similar studies on HHFW in other Mediterranean countries such as Algeria (Ali Arous et al., 2017), Egypt (Elmenofi et al., 2015; Abdelradi et al., 2018), Lebanon (Charbel et al., 2016), Morocco (Abouabdillah et al., 2015), Tunisia (Sassi et al., 2016), Montenegro (Berjan et al., 2019) and Turkey (Yildirim et al., 2016; Salihoglu et al., 2018). All the above-cited studies urgently call for action addressing household food wastage given its negative environmental (Hall et al., 2009; WRAP 2011; FAO, 2013; Chapagain and James, 2013; Quested et al., 2013; FAO 2014; FAO 2015; Shafiee-Jood and Cai, 2016), economic (HLPE, 2014; Principato, 2018; Rutten, 2013; TEEB, 2018) as well as ethical (Stuart, 2009) implications.

Despite that, food waste is not specifically addressed in waste management strategic documents and policies in Albania. A recent report on waste management in South East Europe (Eunomia Research & Consulting LTD, 2017) shows that Albania still has many gaps in its waste management system and lags behind with respect to other countries in the region. This has implications in food waste management. Furthermore, there are only a few initiatives on food waste reduction in Albania e.g. Food Bank Albania (Box 2), which are mainly active in Tirana and other main cities in Albania. For instance, Tirana is among the cities that through local initiatives and policies (e.g. in agriculture/food, energy, water, health, transport, waste sectors) is rising up to the challenge of reducing food waste in the framework of the activities of the Milan Urban Food Policy Pact (United Nations – Albania, 2017).

Evidence shows that focusing attention on the reduction of food waste generated by households is likely to yield faster results. Kummu et al. (2012) argue that the largest global potential for food losses and waste reduction is in agricultural losses and consumption waste, including household food waste. Therefore, communication campaigns should target consumers with the objective to raise awareness on the issue of food waste. Monier et al. (2011) recommend conducting consumer education campaigns and facilitating increased surplus food donation (cf. food banks) to prevent and/or reduce food waste. However, education campaigns should be included in broader intervention programs that address various food waste related behaviours such as planning, shopping, storage, preparation and consumption practices (Schmidt and Matthies, 2018).

Some potential causes of food waste result from business practices and private standards set at higher levels than those set by the government e.g. the "best before" date displayed on food products (NRDC, 2013). Likewise, marketing and sale strategies influence waste behaviour of individuals (e.g. Aschemann-Witzel, 2018), especially youths (Mondéjar-Jiménez et al.,

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Box 2. Food Bank Albania.

Food Bank Albania is a non-profit organization dedicated to the fight against food waste in Albania. It does so by raising awareness throughout Albanian society about food waste. It combines the goal of reducing food waste with that of eradicating poverty as it believes that these two issues are strongly linked i.e. distribution of food surpluses, instead of wasting them, contribute to improving the living conditions and food security of the poor in Albania (Food Bank Albania, 2019a). To address food surpluses, the Food Bank works with businesses (e.g. supermarkets, farmers), Albanian Red Cross, institutions and individuals to collect food donations and raise awareness about food waste. The collected food is provided to NGOs (over 40 NGOs work with the Food Bank), social soup kitchens (10 soup kitchens throughout Albania) or the state social services involved in the fight against poverty (Food Bank Albania, 2019a, 2019b). In 2018, it managed to distribute 100,000 kg of food surpluses (Food Bank Albania, 2019b). Food Bank Albania also highlights that giving food surpluses to the needy Albanian households can reduce the environmental costs of food waste (Food Bank Albania, 2019a); for instance, it argues that food distributed in 2018 prevented up to 96 tons of CO_2 from being released into the atmosphere from potential food waste (Food Bank Albania, 2019b). Food Bank Albania also provides tips to help Albanian households reduce food waste, save money and protect the environment (Food Bank Albania, 2019a). However, one of the obstacles to the activities of the Food Bank is that the law on food donations in Albania does not include an interesting tax system, which implies that the Food Bank should put continuous efforts in fundraising (European Food Banks Federation, 2018).

2016), so that retailers can play an important role in preventing food wastage. Therefore, the private sector should be more engaged in the reduction of food waste throughout the food supply chain through various initiatives such as innovation (e.g. technologies, packages, production processes) and corporate initiatives such as consumer education (BIAC, 2013; Bygrave et al., 2017; Di Terlizzi et al., 2016).

Cooperation among all actors of the food supply chain is crucial to reducing food wastage (e.g. Göbel et al., 2015). Besides state institutions responsible for environmental protection and waste management, NGOs should have a more active role in food waste reduction initiatives. NGOs – in cooperation with public institutions and the private sector – can play an important role in initiatives such as educational campaigns directed to consumers and industry and food recovery as well as knowledge dissemination activities. National campaigns, such as consumer education campaigns on reading "use by" or "best before" date labels, can help change consumer behaviour (NRDC, 2013) contributing to the prevention and/or reduction of HHFW. Such campaigns should focus on youths, who prove to be the population segment most inclined to waste food (Mondéjar-Jiménez et al., 2016; Principato et al., 2015) and on concrete practices such as waste sorting, which was found to be positively associated with food waste reduction (Secondi et al., 2015). Kambo et al. (2017a) suggest focusing on awareness raising campaigns improving Albanian consumers skills to cook as much as needed, as well as their shopping planning skills. Principato et al. (2015) proposes that actions against food wastage, especially educational campaigns, should also target marketers, retailers and policy makers.

3.8. Study limitations

In general, the major constraint faced during research, was the shortage and/or difficult access to adequate, reliable and updated, (both published and non-published), secondary data on FWL in Albania, as well as, in neighbouring countries (e.g. Montenegro, Macedonia). This made it difficult to discuss and compare obtained results with findings from previous similar studies. In fact, to the authors´ best knowledge, there is no previous journal paper that specifically dealt with household food wastage in Albania. This statement is corroborated by a search carried out in Scopus database using queries "Albania AND food waste" on August 13, 2019; the search yielded only three documents that deal with municipal solid waste in Tirana (Alcani et al., 2010), recycling in Albania (Vozga et al., 2013), and lead contamination of soil due to industrial waste (Alushllari et al., 2019), but none regardingfood

waste or household food waste.

One of the major limitations of the present study is the non-probabilistic sampling design used for data collection as respondents were recruited on a voluntary basis. This also implies a non-representative recruited sample for the adult population in Albania. Online surveys have several biases like unbalanced coverage and location, no control on respondents and self-selection that affect the quality of the results. Furthermore, the cross-sectional study design does not allow interpretation of causal relationships between the variables.

It should be mentioned that the survey results of Albania is by no means representative for the entire population of the country concerned. There were more females and more consumers from urban areas in the population under study. One of the reasons for these discrepancies may be the sampling technique used. However, having a higher number of women in the sample is rather normal in food-related studies, since women generally have more of the responsibility for cooking and shopping than males, and are more willing to answer questionnaires related to food issues (Stancu et al., 2016). Another limitation is that the questionnaire was sent via Internet to different respondents and it can be assumed that mainly people with a distinct interest in environmental issues and sustainability with higher level of education were willing to spend their time answering (Jörissen et al., 2015).

The study used self-reported data and did not control for respondents' emotions, affects or perceptions. Thus, mono-source bias and social desirability bias (De Jong et al., 2010) might have distorted or inflated the parameters of interest. Moreover, all data were collected using the same method (cf. online survey) so that common method bias may be an issue. While household food waste surveys are methodologically simple, they are mainly useful to provide qualitative information, because quantification of food wastage (cf. weight of food purchased and discarded, so not consumed) is prone to error as consumers often tend to underestimate their waste (and food waste) when self-reporting (e.g. Beretta et al., 2013; Neff et al., 2015; Simunek et al., 2015; Ventour, 2008).
Last but not least, the questionnaire was prepared in English, then translated into Albanian and this may have affected the Albanian respondents' understanding of issues regarding food wastage and, consequently, their answers.

4. Conclusions

The survey has tackled an important, although unexplored issue on Albanian food habits and practices as well as their implications in terms of household food wastage. Mapping the determinants of waste generation at the household level helps to deepen the understanding of food-related household practices. It emerges that food waste is a concern since several issues regarding food shopping and meal planning at the household level are underestimated. Firstly, there is the issue of poor management in food purchasing and meal preparation. In fact, a considerable amount of food waste is generated because food has not been properly stored or it has been purchased in inappropriatly sized packages. Furthermore, it has been shown that there is very low awareness on the negative impact of food waste due to a lack of campaigns, proper information and public initiatives on this issue. It seems that food habits of Albanians have radically changed and the alleged ancient parsimony on food consumption is rapidly losing ground. The paper highlights that focusing attention on waste generated at the consumer level is likely to yield positive results in food waste prevention and reduction strategies. Therefore, a comprehensive raising of awareness on the value of food saving both in environmental and socio – economic terms is needed, especially among young Albanians. From this point of view, useful evidence has emerged from the survey, confirming that the respondents can be ready to modify their food-related attitude and beahvior leading to food wastage if correct information is given on the negative environmental and economic impacts of food waste as well as on organizations dealing with food waste such as food banks.

To the best of our knowledge, this is the first paper that addresses household food wastage in Albania. However, the present study was not without limitations. Therefore, future research should consider collecting data from multiple sources (cf. face-to-face survey, diaries, waste sorting) and/or at multiple times. The use of a longitudinal study design would allow better analysing causal relationship between determinants (cf. food purchasing, preparation and consumption

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practices) and food wastage. Likewise, the use of data collected from different sources and using different methods could avert the potential method bias. It is also necessary to increase sample size and improve territorial coverage in future studies.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Spatial variation of nutritional content in enhalus acoroides (L.f.) royle seeds and seed pods

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Enhalus acoroides, seeds, seedpods, nutrition, essential minerals.

Coastal and small islands communities generally have limited access to fresh vegetables. The tropical seagrass Enhalus acoroides fruits during the rainy season, when sea conditions often prevent fishing. Coastal communities in several countries, including Indonesia, traditionally collect seagrass fruit for food and traditional remedies. This study measured levels of 6 key nutrients in Enhalus acoroides fruit (seeds and seedpods). Samples were collected from two sites where E. acoroides fruits are harvested (Bulukumba, Selayar), and one unharvested site (Makassar). Interaction between collection site and fruit part was significant for 3 nutrients (P, K, ß-carotene). Nutrient content differed significantly between fruit parts, with higher P and Zn levels in seeds than seedpods. Levels of Ca and Fe were significantly higher in fruit from the unharvested site (Makassar), most likely due to environmental conditions. The Ca, K, P and Fe levels in E. acoroides fruit compared favourably to common vegetables.

1. Introduction

Coastal and small island communities tend to depend heavily on marine resources for their food. Their land is often limited and/or unsuitable for agriculture and the access to markets or shopping centres where agricultural produce could be purchased is often limited; thus, vegetables are often in short supply. Furthermore, small-scale fisheries are also affected by the seasons. During the rainy season, fishermen are often prevented from going to sea due to rough weather, causing them and their families to rely heavily on food collected by gleaning in sheltered shallow coastal waters. The fruit of some seagrasses have long been consumed as food by coastal and small island communities in several countries, including the Philippines, Hawaii, Australia, and the Pacific Islands (Montano et al., 1999; Nontji, 2007; Setyati et al., 2003; Wakano, 2013). Seagrass fruits are known to contain nutrients such as protein, carbohydrates, fats and fibre;, they can be used to increase immune system activity to combat degenerative diseases or infections and as remedies (Badui, 2010). The fruit of the seagrass E. acoroides can be consumed raw or boiled (Alino et al., 1990).

Several coastal communities in South Sulawesi consume E. acoroides fruit; however, each community is likely to have specific processing and cooking methods. For exam-

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ple, Pe-people in Bulukumba generally consume the fruit whole (seeds and seedpod), while people in Selayar only consume the seeds. This research evaluated the nutritional content of E. acoroides fruit, specifically, 6 micronutrients (Ca, P, K, Fe, Zn, and ß-carotene). The goals of this study were to determine the variation in micronutrient content between the seeds and the seedpods of E. acoroides from different locations, including Makassar where E. acoroides fruit is usually not considered as food and to evaluate the potential of E. acoroides fruit as a source of nutrition for coastal communities. The results will contribute to knowledge about coastal and marine resource-use for human nutrition, particularly, alternative sources of nutritious plant-based foods for people living in coastal and small-island communities.

2. Materials and Methods

Study sites and data collection

Fruits of the seagrass E. acoroides were harvested during August-October 2017 from three research sites: Kodingareng Lompo Island, Makassar City (5°8'57.2" S, 119°15'36.0" E); Tanaberu Village, Bulukumba Regency (5°32'39.7" S, 120°22'4.0" E), and Mekar Indah Village, Selayar Island (5°59'26.9" S, 120°26'51.5" E). The sites were determined based on the extent of seagrass fruit use: whole fruit (seeds and seedpod) in Bulukumba; seeds only in Selayar; and fruits rarely eaten in Makassar.

Samples of the young E. acoroides fruit (mostly selected for consumption) were collected and then cleaned with fresh water to remove any sand and salt attached to the fruit. The wet samples were then put in a plastic bag and stored in a cool-box. Samples were sorted, and the seeds were separated from the seedpods. The seeds and the seedpods from each sample were then weighed separately.

Mineral content (Ca, K, Fe, Zn, P)

In order to determine the content of four essential minerals (Ca, K, Fe, and Zn) in E. acoroides seeds or seedpods, a 1-gram aliquot of each part of the fruit from each sample was reduced to ash in a furnace. A 3-5 ml volume of concentrated HCl was added and then diluted to 100 ml. The solution was filtered through Whatman No.42 filter paper, then placed in the AAS (atomic absorption spectrophotometer) by AOAC, (2012) and the measurements recorded.

The phosphorus (P) content was determined by reducing a 1-gram aliquot of each part of the fruit from each sample to ash in a furnace. A 3-5 ml volume of concentrated HCl was added and then diluted to 100 ml. A volume of 1 ml was pipetted into a 50 ml volumetric flask to which 3 ml of ammonium molybdate solution and 2.5 ml of ascorbic acid solution were then added. The mixture stood for 30 minutes before being placed in a UV-VIS spectrophotometer at a wavelength of 570 nm (AOAC, 2012); the phosphorus content was recorded.

ß-Carotene content

The ß-Carotene content of each part of the fruit was determined by mixing 20 grams of the relevant fruit part with 70 ml of acetone and 15 ml of water and placing it in a 100ml volumetric flask with petroleum ether. The ß-carotene was filtered using Whatman No.1 filter paper. The sample was then placed into a test tube and centrifuged at as speed of 4000 rpm. The sample was then placed in a spectrophotometer at a wavelength of 460-480 nm (AOAC, 2012) and the ß-carotene pigment content was recorded.

Statistical analysis

Analysis of variance (ANOVA) was implemented to evaluate the differences of nutrient content between E. acoroides fruit parts and between sites and the interaction between site and fruit part. If the results of the ANOVA indicated significant differences at $\alpha = 0.05$, Duncan's post-hoc test was implemented. All statistical analyses were implemented in SPSS Statistics 21 software.

3. Results

The data on phosphorus (P), potassium (K), and ß-carotene content indicated significant interaction between site and fruit part, while for the other three nutrients (Ca, Fe, and Zn) the interactions were not significant (Table 1). Nutrient content differed significantly based on fruit part for phosphorus (P) and zinc (Zn), and by site for calcium (Ca) and iron (Fe).

The calcium (Ca) and iron (Fe) content of E. acoroides fruit were significantly different between the sites, for both seeds and seedpods (Figure 1). However, there was no significant difference between the fruit parts. The Ca content was higher in fruits from Makassar (6,613.84 mg kg-1) than in those from Bulukumba (1,594.88 mg kg-1) and Selayar (1,884.08 mg kg-1). Similarly, the Fe content of fruits from Makassar (116.17 mg kg-1) was higher than in fruits from Bulukumba (4.76 mg kg-1) and Selayar (11.49 mg kg-1).

The nutritional content of each part of the seagrass fruit varied, as shown in Figure 2. Overall (all three sites combined), the zinc content was significantly different between the seeds and seedpods (Figure 2). The average zinc (Zn) concentration was higher (1.5 mg kg-1) in the seeds than in the seedpods (0.4 mg kg-1).

Data on the nutrient content of phosphorus (P), potassium (K), and ß-carotene showed significant interaction between fruit part and site (Figure 3). The highest phosphorus con-

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Table 1. Analysis of Variance on the nutrient content of E. acoroides fruit (seedpods and seeds) from sites in Makassar City, Bulukumba District, and Kepulauan Selayar District

Nutrient	Source	df	Mean square	F-ratio	Probability	Duncan test result
Calcium (Ca)	Site (L)	2	4.764	267.968	**0.004**	Significant
	Error	2	177798.457[a]			
	Fruit part (B)	1	412653.262	2.321	0.267	Not significant
	Error	2	177798.457[a]			
	L*B	2	177798.457	0.102	0.904	Not significant
	Error	12	1.742			
Phosphorus (P)	Site (L)	2	27779.792	2.351	0.298	Not significant
	Error	2	11817.030			
	Fruit part (B)	1	1053160.631	89.122	**0.011**	Significant
	Error	2	11817.030			
	L*B	2	11817.030	4.985	**0.027**	*Significant
	Error	12	2370.451			
Potassium (K)	Site (L)	2	1.458	2.858	0.259	Not significant
	Error	2	5100477.953			
	Fruit part (B)	1	8938455.542	1.360	0.364	Not significant
	Error	2	5100477.953			
	L*B	2	5100477.953	4.610	**0.033**	*Significant
	Error	12	1106398.472			
Iron (Fe)	Site (L)	2	23416.642	25.538	**0.038**	Significant
	Error	2	916.951			
	Fruit part (B)	1	6.457	0.007	0.941	Not significant
	Error	2	916.951			
	L*B	2	916.951	0.721	0.506	Not significant
	Error	12	1272.093			
Zinc (Zn)	Site (L)	2	1.259	7.025	0.125	Not significant
	Error	2	0.179			
	Fruit part (B)	1	5.481	30.573	**0.031**	Significant
	Error	2	0.179			
	L*B	2	0.179	1.291	0.311	Not significant
	Error	12	0.139			
ß-carotene	Site (L)	2	0.049	0.307	0.765	Not significant
	Error	2	0.158			
	Fruit part (B)	1	0.749	4.727	0.162	Not significant
	Error	2	0.158			
	L*B	2	0.158	6.317	**0.013**	*Significant
	Error	12	0.025			

*) significant interaction between study site and E. acoroides fruit part

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centration was found in the seeds from Selayar (783.34 mg kg-1), while seedpods from Makassar had the lowest concentration (134.18 mg kg-1) (Figure 3A). The seeds from Makassar (MKS-S) had a significantly higher potassium (K) content (5,136.74 mg kg-1) than all the other site-fruit part combinations locations and parts of the fruit (Figure 3B). The ß-carotene concentration was highest in the seedpods of E. acoroides fruit from Bulukumba (1.36 mg kg-1) and lowest in the seeds from Selayar (0.59 mg kg-1).

4. Discussion

Every plant requires at least 16 elemental nutrients for normal growth. Three elements (carbon, hydrogen, and oxygen) are obtained from the air. The remaining 13 elements are provided by the soil and can be classified as either macro or micro elements. Macro elements are needed in large quantities (e.g. Ca, P, and K), while micro elements (e.g. Fe, Zn) and other micro-nutrients (e.g. ß-carotene) are needed in much smaller amounts. To enable normal growth, all nutrient requirements must be fulfilled, either in the form of metal salts or contained within organic compounds such as phosphoproteins or metal-containing enzymes (Lee, 1983).

The calcium (Ca) and iron (Fe) content of E. acoroides

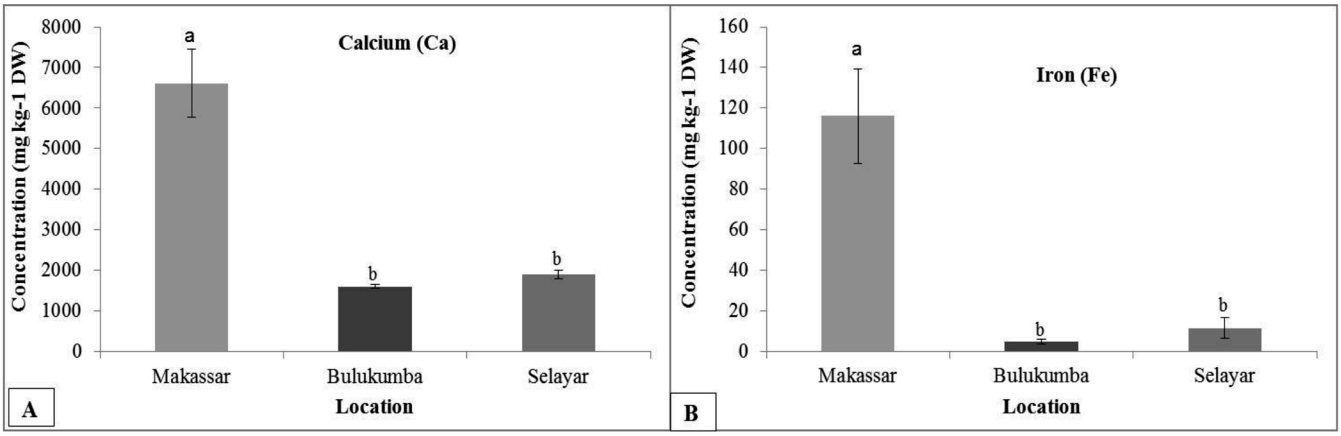

Figure 1. Mean nutrient content of E. acoroides fruit from sites in Makassar, Bulukumba, and Selayar: A) calcium; B) iron. Whiskers denote standard error (SE); lower-case letters (a, b) indicate significantly different values ($p<0.05$). DW=dry weight

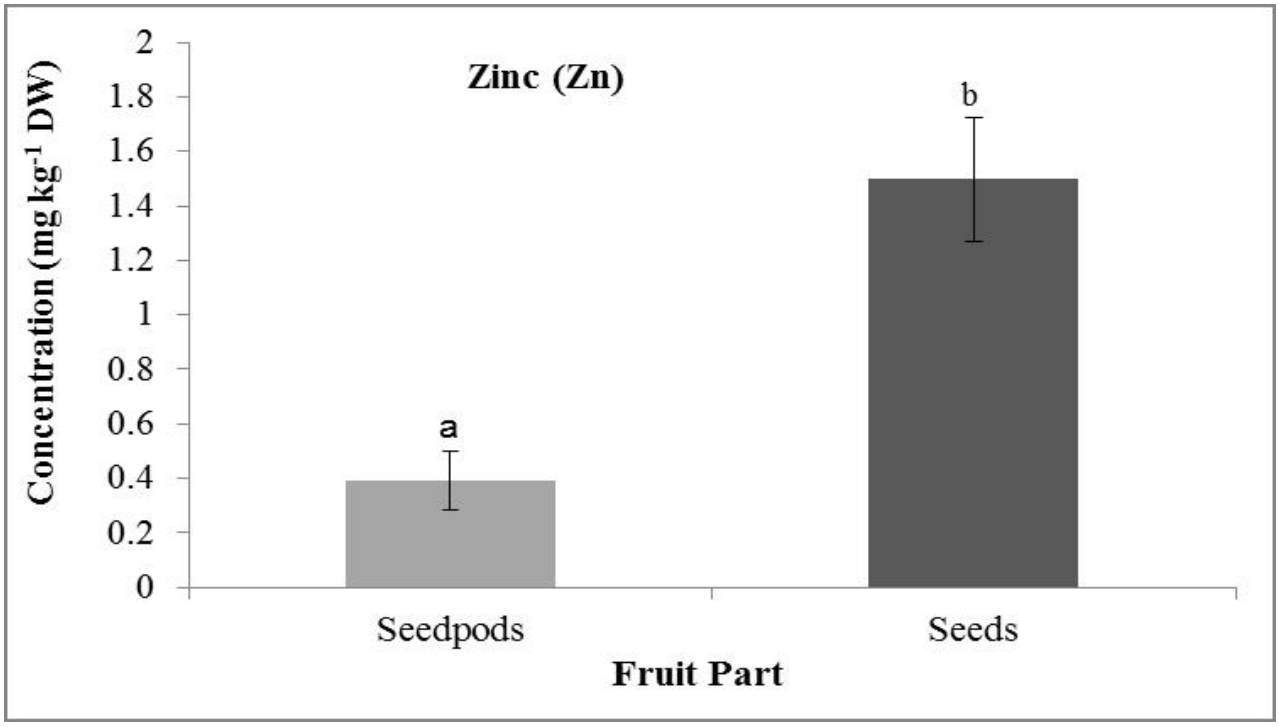

Figure 2. Mean Zinc (Zn) concentration in E. acoroides fruit from sites in Makassar, Bulukumba, and Selayar. Whiskers denote standard error (SE); different lower case numbers (a, b) indicate that the means

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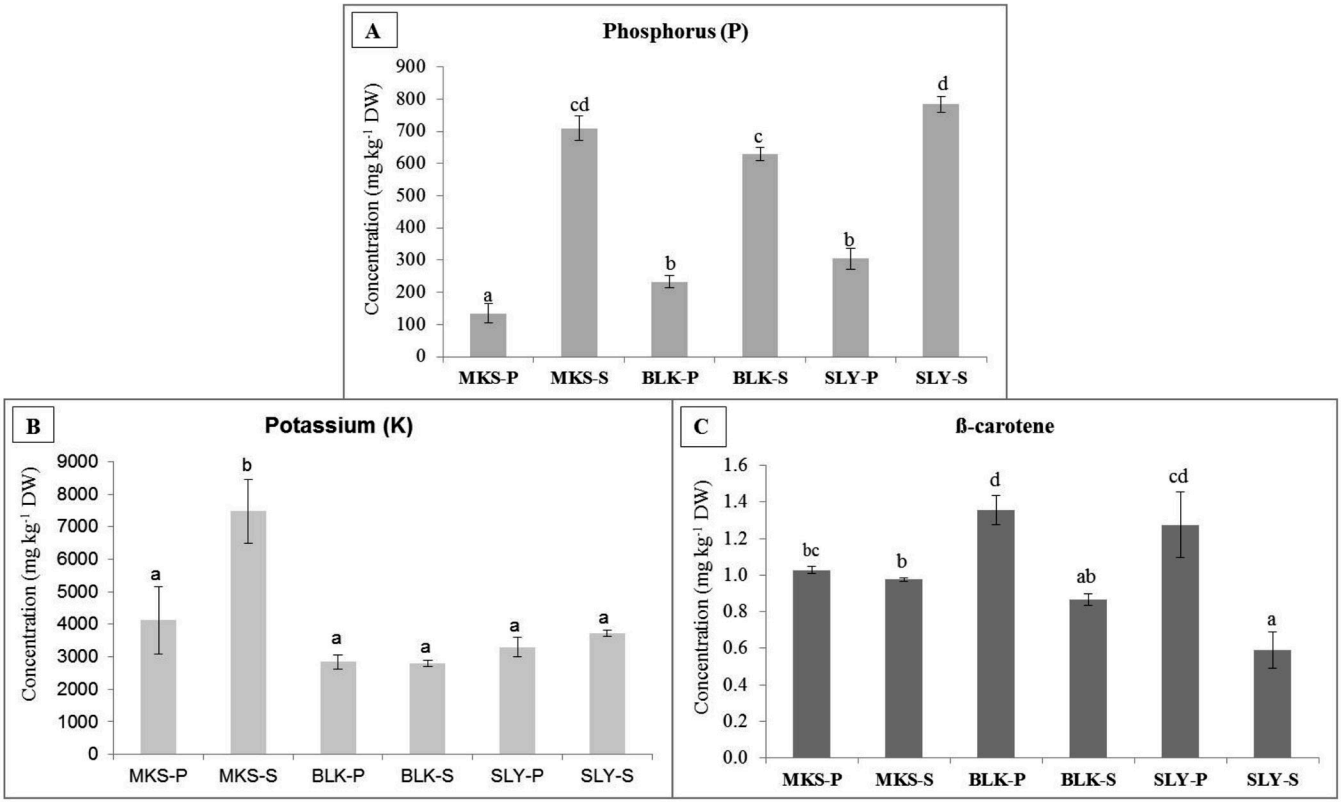

Figure 3. Mean nutrient content of E. acoroides fruit from sites in Makassar, Bulukumba, and Selayar: A) phosphorus; B) potassium; C) ß-carotene. Whiskers denote standard error (SE). Small case letters (a, b, c, d) denote significantly different ($p<0.05$) values. MKS=Makassar; BLK=Bulukumba; SLY=Selayar; P= seedpods, S= seeds, DW=dry weight

fruit was significantly different between the sampling sites, with higher content of both elements at the Makassar site compared to the sites in Bulukumba and Selayar (Figure 1). It is likely that this difference was due to differences in environmental conditions which can affect mineral transfer processes in E. acoroides (Montano et al., 1999; Wan-Hazma et al., 2015). The most influential environmental factor appears to be salinity. Although all three locations had salinity levels within the optimum range for seagrass growth (29-35 ‰), the salinity recorded at the Makassar site during the fruiting season (August - November) ranged from 33.00-34.56 ‰, which is higher than the salinity levels recorded at the Bulukumba (29.67-32.44 ‰) and Selayar (32.00-33.00 ‰) sites (Figure 4). In general, higher salinity tends to increase photosynthesis rates, and can thus contribute to seagrass productivity and density (Short and Coles, 2003). Seagrasses have a considerable tolerance to salinity (Hemminga and Duarte, 2000; Waycott et al., 2004). However, lowering or increasing salinity can influence the performance of seagrass photosynthesis in the adult phase (Kahn and Durako, 2006). Salinity can be influenced by various factors, such as water circulation, evaporation, rainfall, and river flow (Short and Coles, 2003; Nontji, 2007; Ambo-Rappe, 2010).

Calcium plays a role in the process of cell division, controlling the distribution of photosynthesis products, hardening the stems and increasing the number of leaves and flower stalks, and promoting the formation of seeds, so that each fruit or spathe can contain more seeds (Olesen, 1999; Jacob and Pierson, 1981; Lavon et al., 1995). The higher levels of calcium may therefore help to explain the higher mean and median number of seeds in E. acoroides fruit from the Makassar site compared to Bulukumba and Selayar (Figure 5). The mean and median values of seedpod diameter (Figure 5) were also lower in Bulukumba. Although the differences in mean/median seed number were not statistically significant ($p > 0.05$), possibly due to the data spread and outliers (Figure 5), the seedpod diameter was significantly lower in Bulukumba compared to the other two sites ($p < 0.01$). Although the mean diameter was lower in Selayar than Makassar, the difference was not significant ($p > 0.05$). The mean seed weight (total seed weight divided by the total number of seeds collected at each site) followed the median seedpod diameter rather than the median number of seeds, being highest in Makassar (4.78g) followed by Selayar (4.34g) and lowest in Bulukumba (4.07g).

Iron is important for the formation of chlorophyll, carbohydrates, fats, proteins and enzymes. Iron is an essential element because it forms enzymes and proteins that func-

tion as electron carriers in both photosynthetic and respiration phases (Lakitan, 2007). Iron is absorbed by seagrass in the form of Fe2+ and Fe3+ ions. The absorption of iron through leaves is generally considered to be faster than absorption through the roots, especially in plants that are deficient in Fe, because green leaf pigments can mitigate iron deficiency. An excess of calcium will reduce iron availability (Poerwowidodo, 1992).

The zinc content (Zn) in E. acoroides fruit was significantly different between the seeds and the seedpods. One reason why zinc (Zn) content was higher in the seeds than in the seedpods might be because zinc content is related to the presence of proteins (Uribarri and Calvo, 2003). The high vegetable protein content of E. acoroides seed contributes to the sweet taste and crispy texture, as it does in other seeds containing high levels of vegetable proteins (Alino et al., 1990) which can promote wound healing as well as the production and effectiveness of insulin in the human body (Lee, 1983). However, Bouis et al., (2000) consider that the zinc content of plant tissues is genetically regulated, as indicated by plant genotypes with a high Zn efficiency. These plants can produce high dry biomass but have a low Zn content in their seeds. So far, a gene or genes which might control zinc concentration in correlation with Zn efficiecy has not yet been discovered.

Of the six mineral elements tested, only phosphorus (P), potassium (K), and ß-carotene showed significant interactions between study site and E. acoroides fruit part. This means that these three essential elements are influenced by factors associated with each site but are also determined by fruit part. Differences in the nutrient content of the different parts of the fruit are generally influenced by factors internal to the plant, while differences in nutrient content between sites is generally due to environmental factors. Montano et al., (1999) also found that the nutrient content of seagrasses tends to vary depending on species, geographical locations and the minerals present in the surrounding water

The phosphorus content of E. acoroides seeds was significantly higher than that of the seedpods. The seeds are sweet and have a crunchy texture, like that of beans, which also contain high levels of vegetable protein. Phosphorus is an important building block in the production of proteins (Uribarri and Calvo, 2003). Other key functions of phosphorus in seagrass include the storage and transfer of energy within and between the cells, and it serves as a vital component of the genetic system (Cole, 1983). The phosphorus content in E. acoroides fruit differs between locations, being higher in Selayar than in Bulukumba (Table 2). Likely reasons for this include the levels of Total Suspended Solids (TSS) and ammonia, both of which are lower in Selayar than in Bulukumba and Makassar. Lower TSS levels tend to support higher levels of photosynthesis and growth in seagrass. Seagrass requires sunlight for photosynthesis (Nybakken, 1992; Kikuchi and Peres, 1977). However,

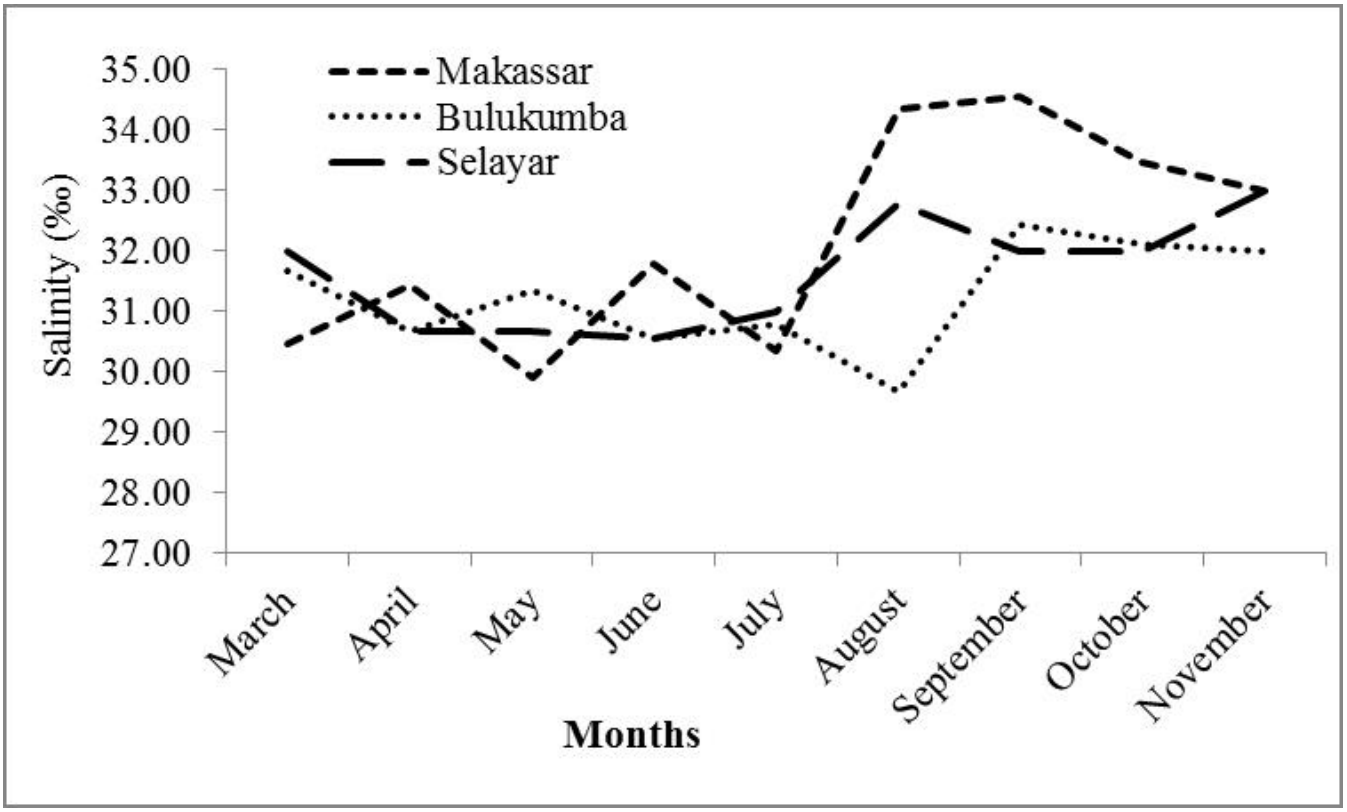

Figure 4. Salinity data at the sampling sites from March to November 2017

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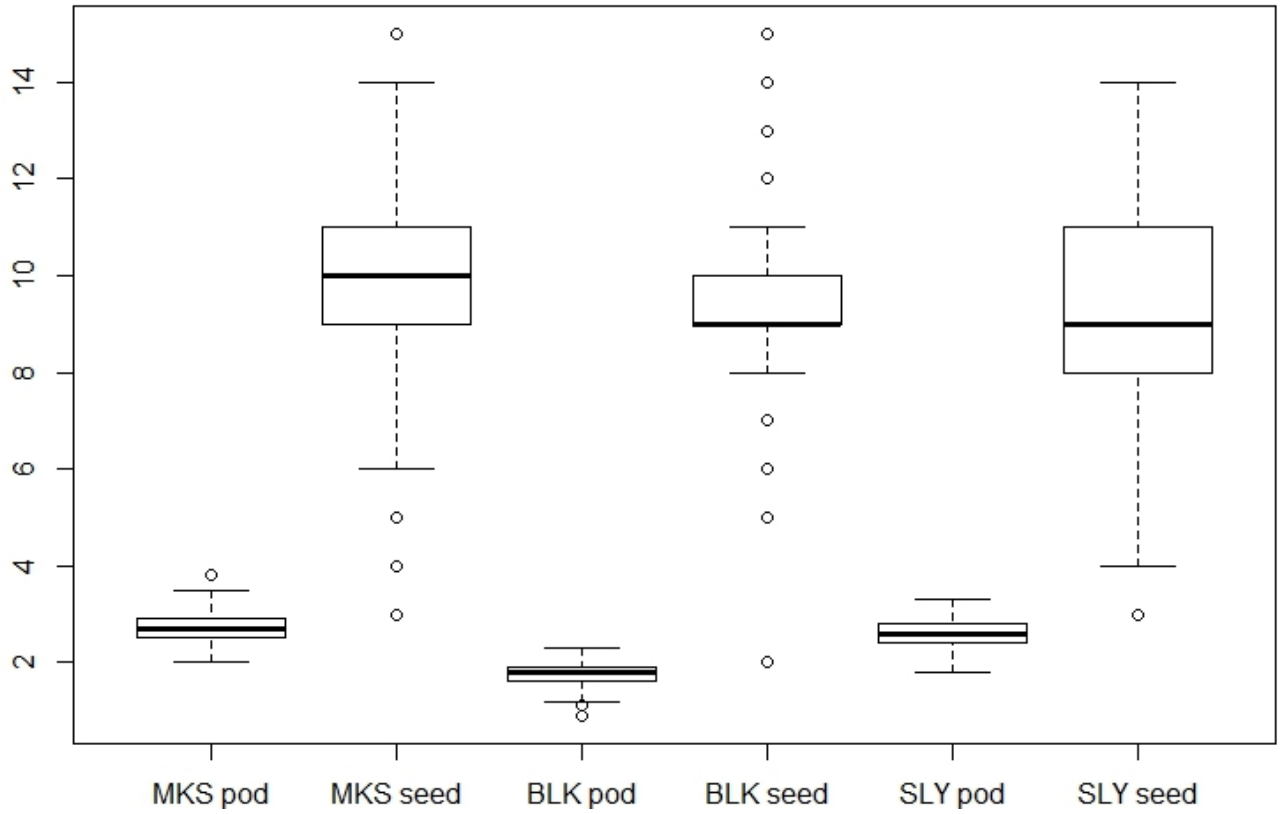

Figure 5. Boxplot of the pod diameter (cm) and seed number per pod of E. acoroides fruit collected from the coastal waters of Makassar City (MKS), Bulukumba District (BLK), and Kepulauan Selayar District (SLY). The bold band indicates the median value (Q2), the boxes indicate the interquartile range (IQR). The upper whisker shows (Q3+ 1.5 IQR) or the maximum data value, whichever is lower; the lower whisker shows (Q1- 1.5 IQR) or the minimum data value, whichever is higher. Outliers are shown as unfilled circles.

turbidity associated with an increase in suspended solids can interfere with light penetration, and thus limit photosynthesis. Sediments suspended in the water column can have a negative impact on water quality, both directly and indirectly, and can lead to a decline in production and an increase in mortality (Ritchie et al., 1976). Ammonia is an organic pollutant which can be present in widely varying concentrations; furthermore, ammonia levels can change very rapidly. Ammonia tends to be toxic to aquatic biota if the concentration exceeds certain levels (Bonnin et al., 2008). The Indonesian Ministry for the Environment has set an upper limit of 0.3 mg/l on the ammonia concentrations in seawater considered suitable for most marine biota (KLH, 2004). The main sources of ammonia in seawater are the breakdown of organic nitrogen (protein and urea) and inorganic nitrogen in the water column, as well as the decomposition of organic matter (dead plants and aquatic biota) mediated by microbes and fungi. High levels of ammonia often result from contamination of organic matter from the discharge of domestic waste, industrial waste, and fertilizer-rich agricultural runoff. The oxidation of ammonia to produce nitrites and nitrates is an important process in the nitrogen cycle and takes place in aerobic conditions. High nitrate concentrations in the water column can stimulate the growth and development of seagrass if supported by the availability of other nutrients (Effendi, 2003).

The potassium content varied significantly, with an interaction between site and fruit part. Potassium (K) levels in the seeds were highest in Makassar, and lowest in Bulukumba. Potassium levels in seagrasses appear to be influenced by PO4 concentration in the surrounding water (Table 2). The PO4 concentration was higher in Makassar than at the other sites; such an increase in potential sources of energy in the seagrass habitat can accelerate the process of seagrass growth (McClintock and Baker, 2001). The K content of the substrate is another factor which can increase the concentration of K+ in seagrass leaves and thus increase its effect on the processes of opening the stomata, absorbing CO2, and photosynthesis. Potassium plays an important role in seagrass growth; it serves as an activator in the energy transport of several enzymes involved in the growth and division of meristematic cells, leading to in-

creased weight, size and volume of various organs (Sjofjan and Idwar, 2009). This is apparent in the higher number of seeds and heavier weight of fruit from Makassar compared to those from Bulukumba and Selayar (Figure 5).

The variation in ß-carotene content also showed a significant interaction between site and fruit part. The ß-carotene content was higher in the seedpods than in the seeds. Compared to other plant tissues, the role of carotenoids in seeds is not as well understood. It seems that carotenoid production in seeds is important for the production of abscisic acid (ABA) and plays a role in seed dormancy (Maluf et al., 1997). During photosynthesis, carotenoids have important photo-protective functions, enabling the absorption of light energy while preventing photo-oxidative damage; they also function as precursors for the biosynthesis of phytohormones (Van den berg et al., 2000; Pogson et al., 2006). The ß-carotene content is influenced by the spongy texture of the seedpod, which enables it to absorb and retain more water; thus, chlorophyll and nutrients generated through photosynthesis which are transported through aerenchyma and lacuna tissues that function like blood vessels in the body, will tend to accumulate in the pod (Shariati and Hadi, 2011).

The ß-carotene levels were higher in Bulukumba than in Makassar (Figure 3). Likely contributing factors include sediment texture, ammonia levels (lower in Bulukumba), and phosphate levels in the sediment (higher in Bulukumba). The sediment texture in Bulukumba is sandy loam with a composition of 78.5% sand, 9% silt, and 12.25% clay, whereas in Makassar and Selayar the sand content in

Table 2. Physical and chemical parameters recorded at the three study sites

Compound	Sample source	Site		
		Makassar	Bulukumba	Selayar
NH_3 (ppm)	Water column	0.036±0.007[a]	0.585±0.005[b]	0.031±0.01[a]
NO_3 (ppm)	Water column	0.026±0.005	0.010±0.003	0.005±0.001
PO_4 (ppm)	Water column	0.513±0.041[c]	0.007±0.001[a]	0.497±0.021[b]
TSS (ppm)	Water column	83.73±1.186[c]	53.12±1.009[b]	45.15±1.000[a]
NO_3 (ppm)	Sediment	15.17±0.856	11.52±1.527	19.26±1.658
PO_4 (ppm)	Sediment	24.87±0.676[b]	24.87±0.453[b]	21.49±0.338[a]
Depth (cm)	Water column	58.04±5.305	72.60±5.386	65.85±7.581
Substrate type	Sediment	Loamy sand	Sandy loam	Loamy sand
Sand content (%)	Sediment	84.19	78.5	88.58
Silt content (%)	Sediment	6.72	9	3.08
Clay content (%)	Sediment	9.06	12.25	8.33

Data are mean values ± S.E in row with different superscript alphabet (a<b<c) are significantly different ($p<0.05$) DMRT, N=8

the sediment exceeds 80% (loamy sand) (Table 2). A higher proportion of clay in the substrate tends to enable the retention of much higher nutrient levels compared to sand. Putri et al., (2016) found the highest proportion (50%) of organic material in mud and clay fractions. A smaller grain size also means that these fractions can store water and nutrients more readily than sand. The organic matter content within the sediments tends to increase when the mud (silt) and clay fractions are enhanced. Sediment is a major source of nutrition for seagrasses, because sediments tend to contain higher levels of nutrients compared to the water column where nutrient levels are generally low (Erftemeijer and Middelburg, 1993).

Phosphates in sediment are the main source of phosphorus for seagrass growth. Phosphate is taken in by the seagrass roots and then delivered to the leaves; very few seagrasses take in nutrients through their leaves (McRoy et al., 1982). According to Lizumi et al., (1982), nitrogen for seagrass growth is mostly derived from sediments in the form of ammonia, whereas nitrates are taken up from the ambient water. Decomposition processes are the main natural source of ammonia and phosphate in seawater, including the decomposition of aquatic plants, in particular the rhizomes and roots of seagrass itself, as well as the remnants of other dead organisms; furthermore, waste discharged from the land will also be decomposed by bacteria and release nutrients into the water (Wattayakorn, 1988; Philips and Menez, 1988; Chester, 1990).

Nutritional value of Enhalus acoroides fruit for human

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Enhalus acoroides fruit are an alternative food source for coastal communities; they can be consumed both as a vegetable and as an ingredient in a variety of dishes (Alino et al., 1990). One factor that affects food quality is the macro-micro nutrient content (Willet, 1994). E. acoroides contains high levels of calcium, potassium, phosphorus, and iron, meeting daily human nutritional needs, but it is low in zinc and ß-carotene. Yet, the content of Ca, P, and Fe in E. acoroides fruit is higher than in rice flour (Montano et al., 1999).

Calcium in E. acoroides fruit was between 1,493 – 6,957 mg kg-1. This range makes a significant contribution to fulfilling the daily calcium requirement of people of reproductive age, which is 1,000 mg - 1,200 mg. The calcium content of E. acoroides fruit is higher than that of many other plant-based foods, for example salad vegetables only contain around 490 mg kg-1 (Pennington and Fisher, 2010).

Enhalus acoroides seeds can also make a substantial contribution to the daily dietary requirement for phosphorus, especially in adult humans (19-70 years) who need to consume around 700 mg of phosphorus per day (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2015). The phosphorus content of E. acoroides seeds is around 783 mg kg-1, which is higher than that of root vegetables such as carrots, which contain about 258 mg kg-1 (Bajaj et al., 1980).

The daily requirement for potassium in adult humans is around 4,700 mg day-1 (Pennington and Fisher, 2010; U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010). The potassium content of E. acoroides fruit ranged from 2,851 mg kg-1 to 7,477 mg kg-1 (mean 5,137 mg kg-1). This potassium level can be considered high, as it compares to those found in bananas, which are considered a major source of potassium with levels around 3,580 mg kg-1 (Mahapatra et al., 2012).
The human dietary requirement for iron, an essential element particularly important for haemoglobin formation, is between 8 and 18 mg day-1 (Pennington and Fisher, 2010; NIH, 2016). The iron content of E. acoroides fruit ranged between 0.057 mg kg-1 and 129 mg kg-1, with an average of 65 mg kg-1. The iron content of E. acoroides fruit was variable, but in general was relatively high compared to other fruits and vegetables; for example, cabbage typically provides around 4.9 mg kg-1 (Pennington and Fisher, 2010).

5. Conclusion

These results demonstrate that seagrass ecosystems serve as an important habitat for various marine organisms and can also provide direct benefits for humans in terms of nutrition. The fruit of E. acoroides (both the seedpods and seeds) contain relatively high levels of essential nutrients such as calcium, potassium, phosphorus, and iron. This fruit can thus be used as a substitute or additional source of nutritious plant-based foods (vegetables). In fact, in terms of certain essential elements, seagrass fruit can rival or exceed the nutritional value of some vegetables and fruit such as lettuce, carrots, bananas and cabbage.

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Conflict of Interest

The authors declare that there is no conflict of interest.

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New Organic-Regulation: Animal husbandry rules for organic farming published

(BÖLW press release translated)

Organic animal husbandry remains true to principles / many changes and innovations
Berlin/Brussels, 06.04.2020.

Photo credit Scott 97006: https://flic.kr/p/2iSaGSm

The Commission of the European Union (EU) has published two legal acts clarifying the new basic organic law (2018/848). Following decisions at the beginning of March, the legislator has now published the implementing act 2020/464 with a focus on animal husbandry rules in the Official Journal of the European Union.

Organic livestock farmers and farms that want to rechange now have planning security for their investment decisions. With the new rules, the EU is consolidating organic as by far the highest legal standard for environmentally and species-friendly animal husbandry: organic-animal husbandry remains area-bound and relies on space in the barn, outlet and organic feed.

Many animal rules remain the same because they have proved their worth – for example, the area requirements for stables and outlets in organic sow, pig and cattle farming. Some rules, such as the rules for organic poultry farms, are changing. The new act, together with the basic regulation, will apply from 1 January 2021. The basic right will be further supplemented in the coming months, for example with rules for crop production or for control of organic farms. A third piece of legislation on dealing with disasters has also been finalised. The release is expected in the next few weeks.

Also published: Regulation 2020/427. It contains supplementary rules on sprouts, bees and aquaculture juveniles. The new legal acts will apply together with the basic regulation from 1.1.2021. Detailed information on the new organic animal rules can be found on the BÖLW website under www.boelw.de/neuebiotierregeln, all information on organic law on https://www.boelw.de/themen/eu-oeko-verordnung/.

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Operational Plan 2021-2025: Consultation

The Global Forum for Rural Advisory Service (GFRAS) and Young Professionals for Agricultural Development (YPARD) are taking your vote for their draft on the Operational Plan for 2021 – 2025 (deadline April 30th,2020)

Photo credit:YARD: https://flic.kr/p/vHmmVi https://flic.kr/p/w1fckt

GFRAS is a global network that contributes to impact at the farmer and value chain level to facilitate sustainable development to achieve the SDGs. YPARD is an international movement established by Young Professionals FOR Young Professionals for Agricultural Development. YPARD was launched in 2006 to serve as a medium for young professionals in agricultural development. It operates as a network and not as a formalized institution.

GFRAS is emphasising the importance of empowerment of young people as ''Today, around 85% of youth live in developing countries, places where agriculture is still the backbone of the economy, the largest employer and the main source of income for a majority of poor people. The picture is changing, rapid urbanisation leads to a decline in the rural population, especially with young people moving to cities to seek jobs and better livelihood opportunities.

The challenges are almost overwhelming and call for new approaches and strategies. To expand their capacity and expertise, the two networks Global Forum for Rural Advisory Services (GFRAS) and Young Professionals for Agricultural Development (YPARD) have decided to combine efforts in their operations at the global level.

This is a deliberate strategic move for both networks that seek to build a critical mass of capacity at the global level to facilitate and support efforts and regional and national level. A logical and direct result of the decision is this joint Operational Plan (OP).

As a response to the increased importance of youth engagement in agriculture both GFRAS and YPARD will capitalise on the new opportunities through involvement of youth in policy dialogue, capacity strengthening of young people and generating and sharing knowledge and advice about effective youth involvement. Young people want to see action on the climate change agenda, they want to have more environmentally friendly agriculture and they want to see more equity in the world."

The joint Operational Plan consists of many activities that are relevant and will add value to rural advisory services providers and the farming communities that they serve. However, it is not possible to apply all of them at the same time and therefore your assistance in setting priorities is required.

So if you are interested in the Operational Plan please read Final Draft: Operational Plan 2021-2025 and reflect upon which activities you believe are most relevant by giving your vote on:

https://www.surveymonkey.com/r/202125OP

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Pesticide Lobbyists Have Been Fighting the EU Pesticide Rules Tooth and Nail, and This Could End Up with Some Success.

EU pesticide regulation has always included a ban on some hazardous substances, of which the most important are the carcinogens and the endocrine disruptors, that can be found on pesticides. For years, EU's plan, the so-called hazard-based criteria, aimed to ban some imported products that may contain particularly dangerous substances. The ban included even the traces of these substances as they are so dangerous unlike other chemicals.

Photo credit Sylvi: https://flic.kr/p/WC13k9
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Through the past years, pesticide producers and corporations in addition to US and Canada have been putting immense pressure to push EU to allow the residues of some pesticides of which EU categorize as hazardous. The pesticide lobbyists want that EU accept the present of banned hazardous substances in food and feed imports.
EU Commission faced never-ending visits, letters and complaints, and sometimes threats, by this pesticides lobby represented by US, Canada and other pesticide corporations. The lobbyists claimed that this ban has a negative impact of international tread of food and feed. In the light of this pressure, EU Commission loosened restrictions and dropped its original plan to ban residues of these dangerous chemical substances in imports.

Hopes now are hanged on the new Commission to stand up for the public health and change this loose approach.

Under its Better Regulation Agenda, the European Commission is undertaking the so-called REFIT (Regulatory Fitness and Performance program) to evaluate two pesticide regulations that govern pesticide residue levels in food. The main aim of the Better Regulation Agenda to alleviate the regulatory burden for business. The final pesticide REFIT report is to be launched at the end of March 2020.

If the new proposal confirmed the fears of accepting residues of hazardous pesticides in importsit would be against the EU's own health protection goals and it would lead to various disadvantages, European farmers would face unfair double standards, and the new Commission's own stated ambitions for the Green New Deal and the Farm to Fork strategy, would be undermined before they have even taken off as those plans contain significant welling to reduced pesticide use and more sustainable imports.

Reference:

Corporate Europe Conservatory (2020, February 16). Toxic residues through the back door, Pesticide corporations and trade partners pressured EU to allow banned substances in imported crops. Retrieved February 19, 2020 from: https://corporateeurope.org/en/2020/02/toxic-residues-through-back-door

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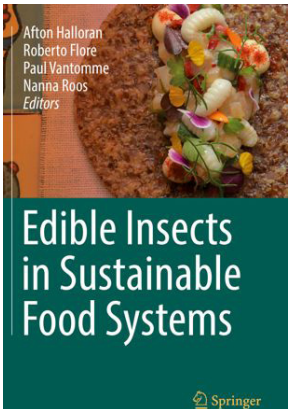

Edible Insects in Sustainable Food Systems

A review by Varsha. V. Prabhu.

Authors: Afton Halloran, Roberto Flore, Paul Vantomme and Nanna Roos
Publisher: Springer International Publishing, Switzerland
Published year: 2018
Language: English
ISBN: 978-3-319-74010-2
Length: 479 pages

In this book, the authors give a detailed explanation of insects for food and feed which would interest anyone dealing with the topic of edible insects in sustainable food systems. The inputs in this book were provided by numerous authors from 20 different nations including public, academic, governmental and private sectors, with a focus on clarifying the role of insects in sustainable food systems. This book covers various topics such as entomology, agricultural economics, human nutrition, environmental science, fisheries and many more. It contains about 500 pages, divided into 8 parts and 30 chapters. Awareness on the biology of insects along with its functions are essential before considering it as a feed and food for society, as it would give an idea about the edible and inedible parts of insects. With this understanding, the book introduces its first section with a brief description on the biology of insects including insect structure, gut functions and growth and development. The role of head, thorax and abdomen is explained in detail with pictures for complete understanding. The book starts with some basic information on the biology of insects, insect structure, gut functions followed by its growth and development. It then specifies methods (light traps, soil digging, and pheromone traps etc.) as some methods to collect particular insects and finally concludes with the importance of understanding the insect biology to consider it as food and feed.

The book further divulges on the uses of insects in Adi-tribe, North-East India. It describes the role insects play, for example in weather-forecasts, myths and beliefs, and entertainment. In addition, it relays several historic practices regarding consumption of certain insects by intuits in the Arctic and the indigenous uses of insects in North American.

Insects possess high nutritional properties and are a valuable food source for the human diet. Following some of the more traditional uses, the next part of the book addresses the direct health benefits of insects as food. The next part of the book addresses on the health benefits of incorporating insects in the diet. The book compares the nutritional properties of insects with that explains the nutritive value This is explained by comparing the nutritional composition of the insects with meat and fish, in particular protein, fats, vitamins and minerals to make the readers understand its benefits on health and the environment. The book also accentuates nutritional insecurity in East-Africa and the potential use of insects to mitigate it. Further, it delves into the harvesting and processing of insects and their contribution towards food and nutrition security in East Africa. Additionally, it includes a brief analysis of food safety aspects specifically biological and chemical hazards related to insect consumption.

The book apprises the readers on exotic foods using insects, developed by chefs, such as a charred avocado tartare with ant larva or a pineapple dessert with leaf cutter ant. In addition, the book sheds some light on the growing positive attitudes of future chefs towards insects as food. This was justified from an experiment conducted some by the Chefs. The second chapter proceeds further with Casu Marzu as an example of insect application in production and processing in Italy. The final chapter discusses a case study on the current use of edible insects in Korea and its innovations in gastronomy.

Environmental impact of insect production is lower than livestock production. The next part of the book revolves around this concept. It compares insect production with livestock production in terms of land usage, water footprint,

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carbon footprint, etc. and thus concludes insect production as a sustainable source of food when compared to livestock production. Insects need specific harvesting methods when compared to normal food. The book therefore encloses the traditional methods of harvesting insects in Sub-Saharan Africa.

After focussing on insects as food and their impact on health and the environment, the book directs the readers on insects as animal and marine feed. The first chapter compares the small-scale productions of the black soldier fly (Hermetia illucens) and the house fly (Musca domestica) as feed,in terms of performance, user-friendliness, safety and sustainability. It further draws attention towards the safety regulations of insects as feed. The following chapter sheds light on the DESIRABLE project funded by the French national research agency. The project evaluates the performance of larvae mealworm (T. Moliter) for feeding fish and poultry. In short, this chapter deals with new insect value chains and explains the insect rearing and processing. Production of insects in small scales can improve the livelihood of small-scale farmers as well as mitigate the dependency on the marketed animal feed thus improving small scale economies as well as the sustainable development of their regions. Hence the next chapter centres on the need for insects in small scale production and the use of these insects as animal feed in low-income countries. The last chapter highlights the production of mealworm for animal feed as well as food.

After discussing insects as feed, the book furthermore focuses on the importance of consumer's preferences and acceptability. It focuses on consumer's attitudes towards insects in Europe, USA and Kenya.

The last part is divided into five chapters that deal with the policies and legislation on the use of insects as food and feed. The first chapter highlights the PROteINSECT research project which provides details on the application of insects as feed. The other chapters mainly focus on the legislation of insect harvesting, processing and growing in Thailand, Africa and the Global South.

Overall, the book delves into multiple topics and provides detailed information about each topic. The book uses simple and clear language. The reader can learn something new in every chapter, however, due to to the occassional repetition of information, the reader may tend to lose interest throughout the different chapters. All in all, the book is a good read to get comprehensive knowledge and tweak the reader's interest in the intended direction.

Information about the author:

Varsha. V. Prabhu. She is a student pursuing her Master of Science in International Food Business and Consumer Studies in Kassel University. She is a food technologist by profession and is always curious about recent trends in food product development.

Call for Research Papers, Reports, and Book Reviews
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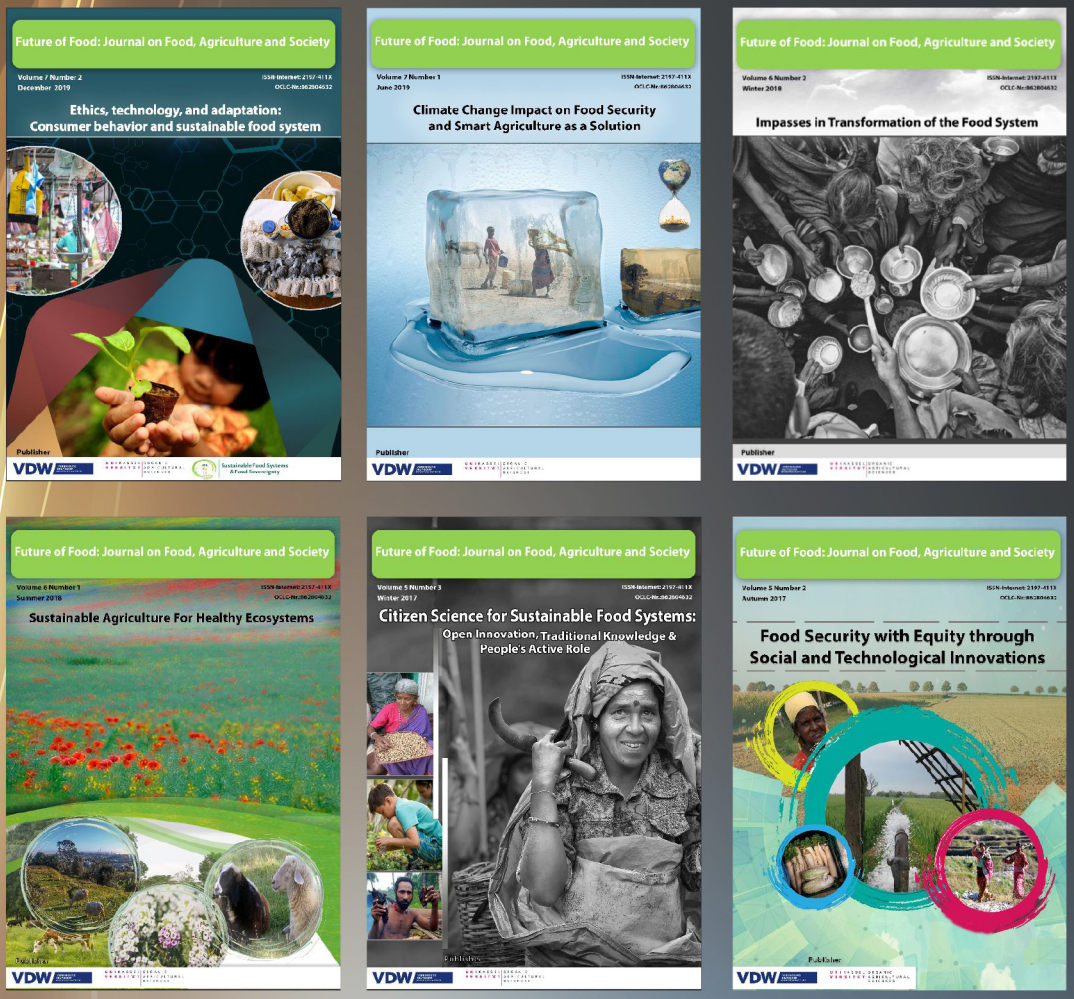

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