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Comparative Studies on Watermelon Production in the North West and South West Regions of Cameroon: A Rural and a Peri-Urban Experience

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Abstract: *Watermelon Citrullus lanatus (Thunb) is a fruit vegetable grown predominantly in the North West Region (NWR) and West Region (WR), both located in the western highland agricultural zones of Cameroon. This industry has a potential in the South West Region (SWR), located in the humid rainforest agriculture zone of the country, although yet to be well established. This study examined the activities of small-scale watermelon farmers in Santa (a rural community in the NWR) and in Buea (a peri-urban community in the SWR). A structured questionnaire and regular farm visits at daily intervals were done to elucidate knowledge gaps and lessons for improving watermelon production in Buea. The study lasted for 3 months (from March to May, 2015). Fifty farmers from each community were selected using the Snowball technique. The results show that farmers from Buea were significantly younger falling within the age bracket of 30 – 39 year (30.1 yrs) than those in Santa with most in the age bracket of 40 – 49 years (48.2 yrs). Youth participation was low for farmers from both regions. Women participation in Santa (30.0%) was significantly higher than in Buea (16.0%). Farmers in Santa had larger farm land (4.8±1.1 acres) than those in Buea (2.5±0.48 acres). Most farmers in Buea had other sources of income; consequently lesser time was devoted on to watermelon production unlike their counterparts in Santa who in many cases were full-time farmers. All the farmers in both locations used agrochemicals. The agrochemical dealers and buyers of the watermelon played fundamental roles in watermelon production. Not only did they supply agrochemicals, but also participated in making decisions on the variety of watermelon to be grown and choice of agrochemicals. Farmer-farmer communication was significantly (P < .05) higher in Santa than in Buea. Land acquisition was a major hindrance for most of the farmers in Buea (90.0%). As such this study recommends that a technical training for farmers and agrochemical dealers should be a priority on the government's agenda so as to enhance watermelon production. Agricultural land should be a key component in urbanization programs. Exchanges on experience and skills among watermelon growers nationwide with women and youth involvement will be very relevant for a sustainable and vibrant watermelon sector. A schematic diagram has been provided with more recommendations.*

Keywords: *agrochemicals, Buea, Cameroon, Santa, watermelon, women, youth*

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I. Introduction

Watermelon (*Citrullus lanatus*) [Thunb] is a vine belonging to the Cucurbitaceae family [1], which is made up of about 118 genera and over 825 species [2]. It originates from Africa and is widely cultivated throughout the tropics, sub-tropics and arid regions of the world [3][4]. Watermelons are very delicious and a very refreshing source of much needed water and electrolytes especially in the scorching tropical-summer temperatures. Watermelon contains 95% water, phosphorus (9 mg), ascorbic acid (8 mg), vitamins (0.64 g), calcium (8 mg), and carbohydrate (5 mg) per 100 g of edible portion [5]. Watermelon is also rich in important substances such as lycopene and citrulline which are associated with improved heart and liver functions [5]. Watermelon is consumed directly as desserts all over the world. In some parts of Africa, the seeds of watermelon are roasted and eaten [6], and also used to produce oil [7].

China is ranked the highest producer of watermelon, producing approximately 70.2 million metric tons (about 66.43% of global market) annually, followed by Iran, Turkey and Brazil [8], which jointly produced about 2 million metric tons in 2011/2012 growing year [8]. It is also reported that in spite of the high yield potentials of watermelons, the aforementioned countries often have low yields of about 40 tons ha^{-1} or less. Notwithstanding, countries such as Greece and Cyprus attain higher yields of about 62 tons ha^{-1}[8][9]. Watermelon production in Cameroon is still very low, producing just over 73,800 metric tons (about 0.06% of the global market share) with a net zero import and export of watermelon [10].

In Cameroon, the market price of a marketable fruit varies from 500 FCFA to 3000 FCFA per fruit (about 0.8 to 4.6 €) [11]. Although watermelon production in Cameroon has increased over the last two decades, nothing near the full potential has been exploited to supply the domestic and international markets, as a result missing out in a very potential income and foreign exchange source. Pre-harvest and postharvest challenges might contribute to this low level productivity of watermelon [12]. Watermelon production in Cameroon is dominated by the West and the North West Regions producing almost 70% of the nation's demand of watermelon [12]. Whilst areas of the South West Region such as Buea and its environs with a tropic humid condition, nutrient-rich volcanic soils [18] has a great potential for watermelon production, which is regrettably underexploited in Buea (per. com).

This study was intended to ascertain the differences in the watermelon production systems in two regions; from a rural and a peri-urban community with the same production capacity. Differences elucidated will help to breach knowledge gaps within these two regions relevant to boost the sector in Buea (SWR) as is the case in Santa (NWR). To accomplish this, the following objectives were underscored:

- To evaluate the different agronomic practices used by watermelon farmers in Buea and Santa
- To ascertain the major pests and disease constraints in the watermelon production system in Buea and Santa
- To understand the agrochemical use patterns in Buea and Santa by watermelon farmers.

II. Material And Methods

2.1 Study sites

Cameroon has four agro-ecological zones; the western highlands (North West and West Regions), the humid rain forests (East, Center, South West and Littoral Regions), the central savannah (Adamawa and southern part of the North Region), and the sudano-sahelian region (northern part of the North Region and the Far North Region) [14]. The study was conducted in two of these zones: North West Region (NWR) located in the western highlands and South West Region (SWR) located in the humid rainforest.

In each of these regions, a watermelon growing community was selected and 50 watermelon farmers from each community were interviewed.

2.1.1 Santa (North West Region)

Santa is the headquarters of Santa Sub-Division, located in Mezam Division of the NWR (fig. 1). More than 80% of her rural population depends solely on agriculture, including a strong livestock sub-sector. The climate of this region is the tropical humid type with two seasons which are the dry and rainy seasons. Average precipitation is in the range of 2000 to 3000 mm with average temperatures of around 20˚C. The relief of the area is mountainous with many plains and plateaus. The altitude ranges from 1000m - 2500m above sea level. The soils of the Western Highlands of Cameroon are ferralitic, of volcanic origin and rather fertile although soil pH is on the low side [15]. Owing to its fertile soils and climate which favors agricultural activities, varied food and cash crops are being cultivated [14]. Major crops cultivated here include tomatoes, spices, potatoes, beans, maize, watermelon and some root crops such as carrots [16]. Watermelon cultivation is a well established activity in Santa.

2.1.2 Buea (South West Region)

Buea is the headquarters of Fako Sub-Division (fig. 1). The town is known for its many higher institutions of learning and the host of Mount Cameroon; the highest mountain in West Africa. Neighbouring towns such as Muea and Tole now host a reasonable number of people who are into fruit and vegetable production [16]. Common fruits grown include tomatoes, pepper, and watermelon to a lesser extent. Buea is in the monomodal humid-forest rainfall zone. It has a humid tropical climate with an annual rainfall of about 2000 mm. The mean annual temperature is about 28 ^{o}C while the average relative humidity ranges from 70% to 80%. The annual sunshine is between 900 and 1,200 hrs per annum. Her topography is mountainous; the soil type is basically volcanic and rich in minerals, making it suitable for agriculture [13].

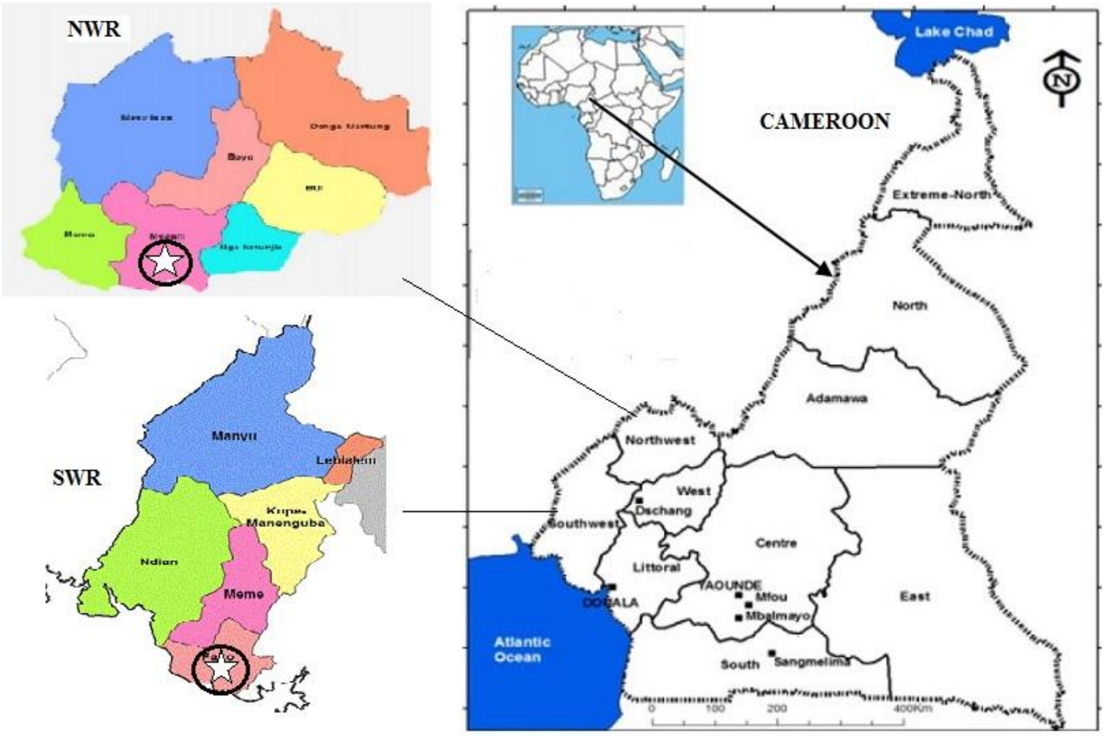

Figure 1. Cameroon map showing the study areas. Starred areas represent the study sites.

2.2 Survey and Data collection

A structured questionnaire was used to obtain the needed information from the watermelon farmers. The questionnaire contained opened and closed ended questions. Additional observations were noted on other activities carried out by watermelon farmers during farm visits. The selected farmers were those who were solely responsible for decision making concerning their respective farms. The questionnaire was designed in English but interpreted into pidgin where need aroused. The study lasted for 3 months (from March to May, 2015).

Snowball or Chain Referral Technique was used as the sampling method. This type of sampling technique works like chain referral where after observing the initial subject, the researcher asks for assistance from the subject to help identify people with similar trait of interest. Not more than 5 farmers were interviewed per day because the exercise was tedious. Fifty farmers were interviewed from each location giving a total of 100 farmers. Frequent farm visits at almost daily intervals were made to ascertain farmer's activities on-farm.

2.3 Data analysis

Differences in variables were examined using student's *t* test for continuous data and chi-square test for categorical data. The statistical package 'Statistical Package for Social Studies' SPSS version 23.0 and the Microsoft tool (Microsoft Excel, windows 8) was used for these analyses and presentations.

III. Results

3.1 Socio-demographic analysis for watermelon farmers in Buea and Santa

Table 1 shows the socio-demographic variables for watermelon farmers in Buea and Santa. Significant differences ($P < .05$) were observed in all socio-demographic variables considered in the study. More women were involved in watermelon production in Santa (n = 15, 30.0%) than Buea (n = 8, 16.0%). Farmers in Buea were significantly younger ($P < .05$) and more educated ($P < .05$) than the farmers in Santa. There was a significant difference ($\chi^2 = 14.32$, $P < .05$) in gender across the location; 16.0% (n = 8) and 30.0% (n = 15) of the farmers from Buea and Santa respectively were females. Ninety percent (n = 46) of the farmers in Santa were married while only about 70.0% (n = 35) of the farmers from Buea were married. The farmers educational level also varied across the locations ($\chi^2 = 7.0$, $P < .05$). Majority of the farmers from Santa (n = 22, 44.0%) had only primary education, while the majority of the farmers from Buea had secondary education (n = 25, 50.0%). Close to one-fifth (n = 8, 16.0%) of the farmers in Santa had no formal education compared to just 2.0 % (n = 1) from Buea.

There was a significant difference ($\chi^2 = 10.31$, $P < .05$) in the proportion of farmers in the different age (years) groups across the locations. Fifty percent (n = 25) and 20.0% (n = 10) of farmers from Buea and Santa respectively could be found within the age bracket of 31- 40 years. In the age bracket of 41 – 50, 20.0% (n = 10) and 34.0% (n = 17) of the farmers from Buea and Santa respectively could be found. Ten percent (n = 5) and 42.0% (n = 21) of the farmers in Buea and Santa respectively were older than 51 years. Overall mean age of the farmers was 30 years and 48 years for farmers from Buea and Santa respectively. The longevity of the farmers' involvement in watermelon production in Buea and Santa were 4.3 (± 0.39) years and 15 (± 3.61) years, respectively. The experience for farmers in Buea ranged from 1 – 7 years while those from Santa ranged from 1 – 30 years. Watermelon farmers in both regions engaged in other activities. Thirty percent (n = 15) and 74.0% (n = 37) of the farmers from Buea and Santa respectively grew other crops. Sixteen percent (n = 16.0%) of the farmers from Buea were students. There were no student farmers in Santa. The farmers in both locations also engaged in trading and teaching.

Table 1. Socio-demographics of watermelon farmers in Buea (SWR) and Santa (NWR)

Variables	**Buea (SWR)**		**Santa (NWR)**		**α = (.05)**
	Frequency	**(%)**	**Frequency**	**(%)**	
Gender					*P* < .05
Male	42	84.0	35	70.0	
Female	8	16.0	15	30.0	
Marital status					*P* < .05
Married	35	70.0	46	90.0	
Not married	15	30.0	4	100.0	
Education level					*P* < .05
None	1	2.00	8	16.0	
Primary	12	24.0	22	44.0	
Secondary	25	50.0	15	30.0	
Tertiary	12*	24.0	5	10.0	
Age (years)					*P* < .05
20 – 30	10	20.0	2	4.00	
31 – 40	25	50.0	10	20.0	
41- 50	10	20.0	17	34.0	
51 – 60	4	8.0	17	34.0	
61 ≥	1	2.0	4	8.00	
Mean (± S.E) age 30.1 ± 1.58			*Mean (± S.E) age 48.2 ± 1.38*		
Longevity (years)					*P* < .05
Range	1 – 7 years		2 – 30years		
Mean (±S.E)	4.3 (0.39)		15 (3.61)		
Other farmers' engagements					*P* < .05
Other crops	15	30.0	37	74.0	
Teacher	12	24.0	7	14.0	
Trader	25	50.0	17	34.0	
Student	8	16.0	0	0.0	

Mean (±S.E) and percentages of 100 watermelon farmers in Buea and Santa. Significant differences for Gender, Marital status, Education level and Other engagements was evaluated using chi square test ($\chi 2$ test) and a t-test was used for variables; Age and Longevity at 95.0% confidence. Percentages in the variable Other farmer's engagement do not add up to 100 before farmers engaged in multiple activities, S.E – standard error of mean, n – number of farmers

3.2 Cropping systems and agronomic practices

Our study revealed that the watermelon farmers in Buea and Santa principally preferred two main varieties of watermelon; Wonder and Sweet Sensation (Fig. 2). There was a significant statistical difference (χ^2 = 71.5, P < .0001) in the choice of watermelon variety. Sixty percent (n = 30) and 24.0% (n = 12) of the farmers in Buea and Santa respectively preferred Sweet sensation. With regards to variety Wonder, 30.0% (n = 15) and 60.0% (n = 30) of the farmers in Buea and Santa respectively preferred it. A small percentage of farmers in Buea (n = 5, 10.0%) and Santa (n = 8, 16.0%) grew both varieties.

Table 2 shows some parameters which influenced agronomic practices of watermelon farmers. The farmer's decision on what variety to grow was significantly influenced (χ^2 = 21.31, P = .002) by three major factors: Buyer's choice, Pest resistance and the Sweet taste of the watermelon. Seventy-four percent (n = 37) and 50.0% (n = 25) of farmers in Santa and Buea respectively, varietal choices were influenced by consumers of the produce. Pest resistant status of the variety played a significant role in just 7.0% (n = 14) and 6.0% (n = 3) of the farmers in Buea and Santa. There was no significant difference (P > .05) in the use of nursery across location. Ninety percent (n = 45) and 94.0% (n = 47) of the farmers in Buea and Santa did not use nurseries in their watermelon production practices. Mix cropping was significantly (χ^2 = 21.10, P = .024) higher with farmers from Santa (n = 15, 30.0%) compared to farmers from Buea (n = 5, 10.0%). Farmers grow watermelon both in the rainy season and dry seasons. Ninety percent (n = 45) and 80.0% (n = 40) of the farmers in Buea and Santa respectively, grew watermelon in both rainy and dry seasons. The sources of water for irrigation significantly varied (χ^2 = 41.23, P < .001) with farmer location. All farmers relied largely on rain water for irrigation. However, dams and dugout pits were used by 24.0% (n = 12) and 60.0 (n = 30) of the farmers in Buea and Santa respectively.

The mean land area (acres) was significantly different (t = 0.32, df = 1, P < .05) across locations. The mean land area under cultivation in Santa was 4.8 acres/farmer and 2.5 acres/farmer in Buea (Fig. 3).

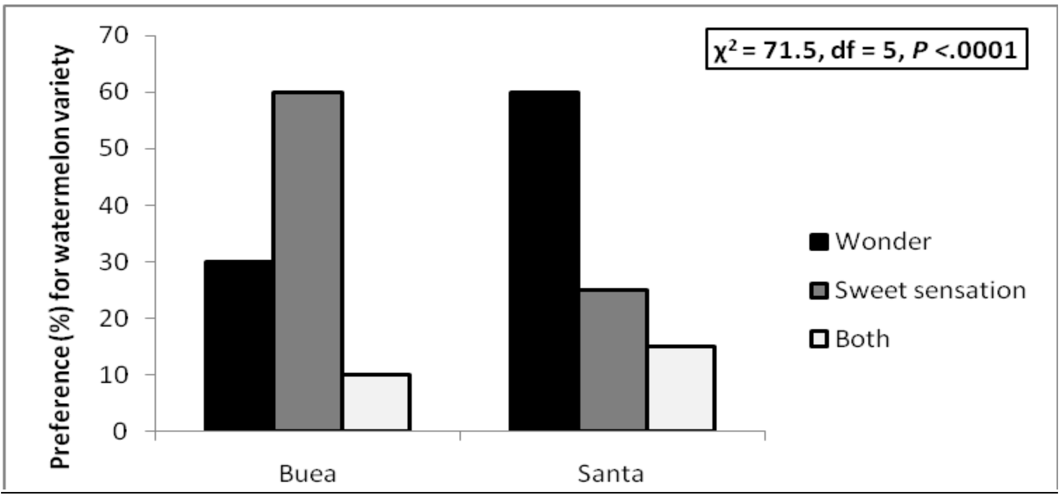

Figure 2. Percentage preference for watermelon variety by farmers in Buea and Santa

Table 2. Watermelon farmers' perception and use of some agronomic variables

Variable	Buea (SWR) Frequency	(%)	Santa (NWR) Frequency	(%)	α = 0.05
Reasons for variety					***P* < .002**
Buyers choice	25	50.0	37	74.0	
Resist pest	7	14.0	3	6.0	
Sweet taste	30	60.0	10	20.0	
Use a nursery					**NS**
Yes	5	10.0	3	6.0	
No	45	90.0	47	94.0	
Mix cropping					***P* = .024**
Yes	5	10.0	15	30.0	
No	45	90.0	35	70.0	
Farming season					**NS**
Rainy season only	5	10.0	7	14.0	
Dry season only	0	0.0	3	6.0	
Both	45	90.0	40	80.0	
Source of water					***P* = .001**
Rain fed	50	100.0	50	100.0	
Dams/dugouts	12	24.0	30	60.0	
Streams/Rivers	25	50.0	10	20.0	

Counts and percentages of 100 watermelon farmers' perception and use of some agronomic gears in Buea and Santa. Chi square (χ2 test) was used to evaluate significant differences at .05. Fisher's Exact χ2 test was used for variable 'Use Nursery and Mix cropping') NS – Not significant, some percentages may not add up to 100% because some respondents gave multiple responses for the same question

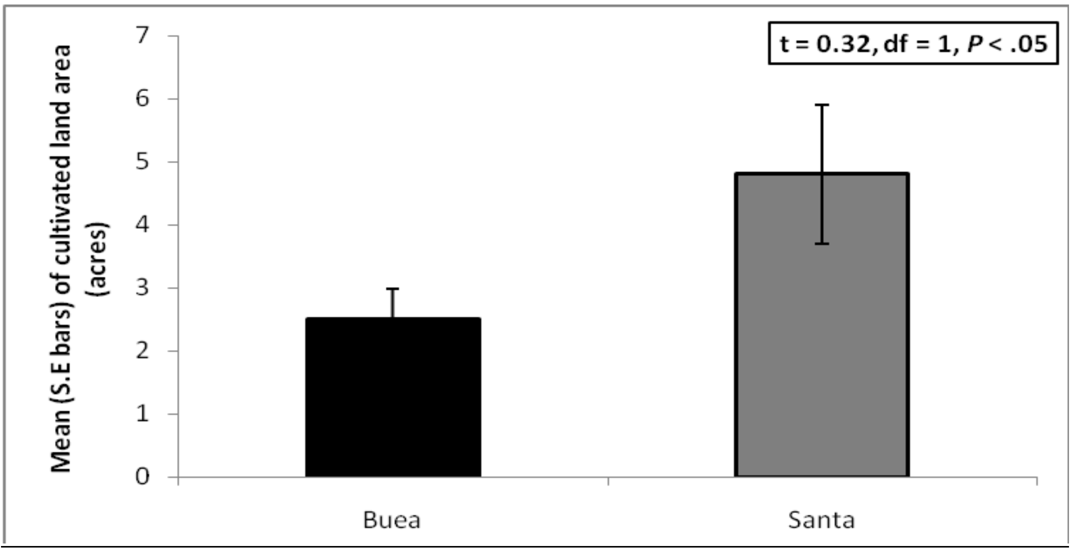

Figure 3. Mean land area (acres) cultivated for watermelon in Buea and Santa

3.3 Knowledge of pests and disease problems

All farmers from both locations experienced some form of pests and disease attack as can be seen in fig. 4. Among the pest problems, 100.0% of the farmers indicated that aphids and snails were of major concern. Next in ranking were thrips, grasshoppers, cutworms and armyworms. Among the diseases, wilt was a major problem to all farmers. Other diseases included watermelon mosaic virus (WMV), damping-off and fruit-blotch.

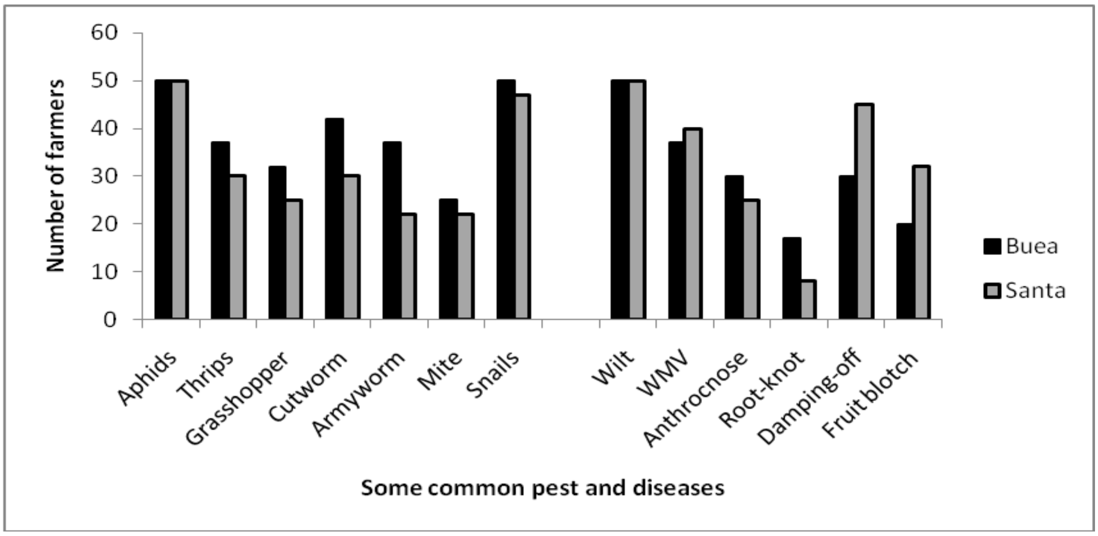

Figure 4. Some common pests and diseases of watermelon expressed by farmers in Buea and Santa

The farmers adopted many control strategies (Table 3) for pests and diseases. All farmers from both regions adopted some form for control of the pest and disease. Cultural control method was preferred by 46.0% (n = 23) and 74.0% (n = 74.0%) of the watermelon farmers in Buea and Santa, respectively. Chemical control was used (100%) by both farmers from Buea and Santa. No farmer was wittingly engaged into any form of biological control.

There was a significant difference ($\chi^2 = 9.12$, $P = .008$) on decision-making pattern on how to spray the watermelon field across location. Sixty percent (n = 30) and 30.0% (n = 15) of the farmers in Buea and Santa respectively, preferred calendar-spray of pesticides. All (n = 50, 100.0%) and 74.0% (n = 37) of farmers in Santa and Buea respectively, sprayed their watermelon field based on the level of pest and disease damage.

Table 3. Pests and diseases control measures, informed decisions used by watermelon farmers in Buea (SWR) and Santa (NWR)

Variables	Buea (SWR) Frequency	(%)	Santa (NWR) Frequency	(%)	α = .05
Exert control					**NS**
Yes	50	100.0	50	100.0	
No	0	0.0	0	0.0	
Method of control					**NS**
Cultural	23	46.0	37	74.0	
Chemical	50	100.0	50	100.0	
Biological	0	0.0	0	0.0	
Informed decision on control					***P* = .008**
Based on calendar spray	30	60.0	15	30.0	
Based on pest/disease damage	37	74.0	50	100.0	
After expert advice	7	14.0	15	30.0	

Percentage of 100 watermelon farmers involved in different pests and disease control strategies in watermelon production. $\chi 2$ test was used to assess the level of significance. NS-Not significant. All percentages do not add up to 100% because some respondents gave multiple answers

3.4 Handling and use of agrochemicals

Table 4 reveals that all farmers use fertilizers and pesticides in their agronomic activities. The farmers significantly differed (χ^2 = 35.579, P < .0001) in the choice of fertilizer across locations. NPK was preferred by 64.0% (n = 32) and 34.0% (n = 17) watermelon farmers in Buea and Santa, respectively. Mixing of agrochemicals before application was a common practice; 70.0% (n = 35) and 54.0% (n = 27) of the farmers in Buea and Santa, respectively. Urea was used by 20.0% (n = 10) and 64.0% (n = 32) of the farmers in Buea and Santa, respectively. Poultry manure was used by all farmers in Santa (n = 50, 100.0%) and 74.0% (n = 37) of farmers in Buea. Table 4 further reveals that all farmers got their agrochemicals from agrochemical shops. Forty-four percent (n = 22) and 30.0% (n = 15) of the farmers in Buea and Santa respectively, got agrochemicals from fellow farmers. Farmers also got agrochemicals from extension agents of the Ministry of Agriculture and Rural Development.

The manner in which the agrochemicals (fertilizers) were used differed significantly (χ^2 = 9.543, P = .002) for the farmers across locations. Sixty-four percent (n = 32) and 90.0% (n = 45) of farmers from Buea and Santa respectively used fertilizers interchangeably. The same fertilizer was used over a long period by 36.0% (n = 18) and 10.0% (n = 5) of farmers in Buea and Santa respectively.

Table 4. Types and sources of fertilizers and pesticides used by watermelon farmers in Buea and Santa

Variable	Buea (SWR)		Santa (NWR)		α = .05
	Frequency	%	Frequency	%	
Types of agrochemicals					**NS**
Fertilizer	50	100.0	50	100.0	
Pesticides	50	100.0	50	100.0	
Pesticides application					***P* < .029**
Singly	15	30	23	46	
Mixing	35	70	27	54	
Types of fertilizers used					***P* < .0001**
NPK	32	64.0	17	34.0	
Urea	10	20.0	32	64.0	
SOA	22	44.0	10	20.0	
Poultry manure	37	74.0	50	100.0	
Cow dung	0	0.00	15	30.0	
Source of fertilizer					**NS**
Agrochemical shops	50	100.0	50	100.0	
Fellow farmers	22	44.0	15	30.0	
Ministry's delegation	10	20.0	22	44.0	
Manner of use of fertilizer					*P* = .004
Interchangeably	32	64.0	45	90.0	
Same fertilizer over a long time	18	36.0	5	10.0	

Percentage of 100 watermelon farmers' perception and use of agrochemical in Buea and Santa. Chi square test was used for the analysis (P < .05), Fisher's exact Chi square test was done for variable 'Manner of use of fertilizer'. NS – Not significant. Percentages may not add up to 100% because some respondents gave multiple responses. NPK – Nitrogen, Phosphorus, Potassium and SOA – Sulphate of Ammonia

There was significantly difference in farmer's preference to pesticides (χ^2 = 9.697, *P* = .021) as seen in figure 5. Insecticides and fungicides were used by farmers from both locations. Thirty percent (n = 15) and 10.0% (n = 5) of farmers from Buea and Santa respectively, used herbicides. A higher proportion of the farmers in Buea (n = 22, 44.0%) used nematicides compared 30.0% (n = 15) from Santa.

The different types of agrochemical mixtures are shown in figure 6. Preference to agrochemical mixtures significantly varied across locations (χ^2 = 31.273, *P* < .0001). Insecticides and fungicides were mixed before application by 80.0% (n = 40) and 50.0% (n = 25) of the farmers from Buea and Santa, respectively. Fungicides and nematicides were mixed by 44.0% (n = 22) and 60.0% (n = 30) farmers from Buea and Santa, respectively.

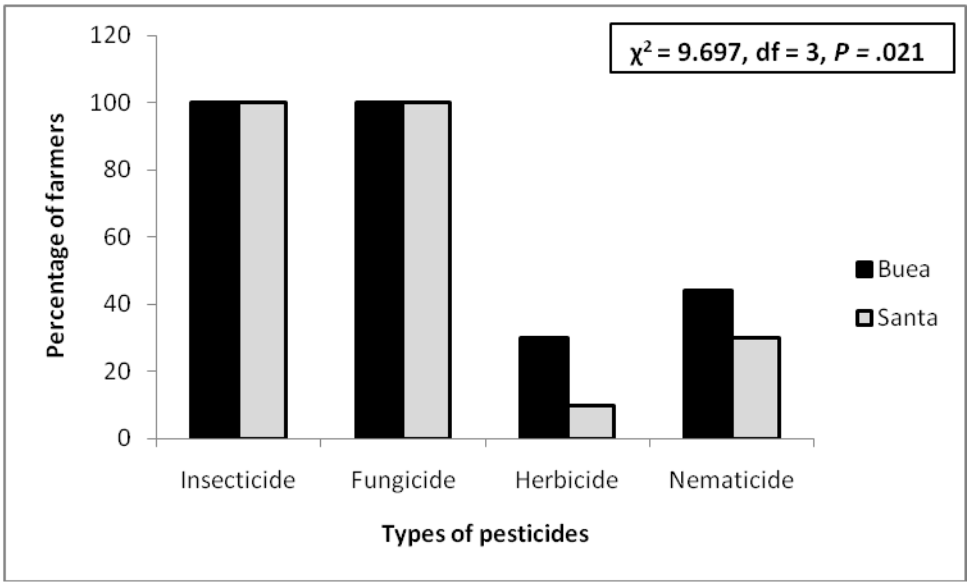

Figure 5. Watermelon farmers' preference for different pesticides and manner of use

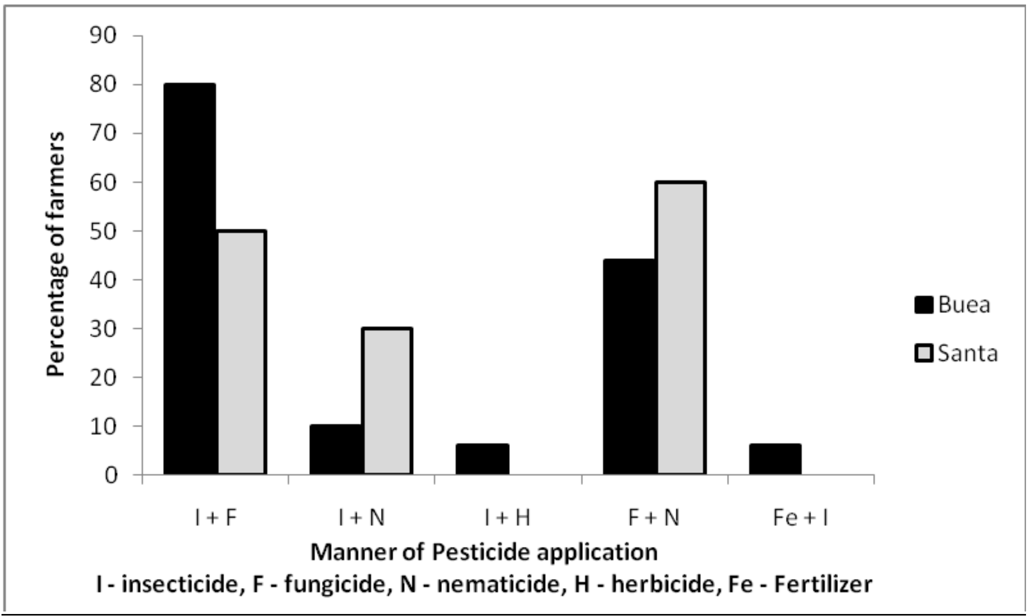

Figure 6: Pesticides mixtures as used by watermelon farmers in Buea and Santa

Farmers had different sources of recommendation for pesticides usage (Table 5). All the farmers however relied on their personal experiences and pesticide dealers for recommendation. Thirty percent (n = 16) and 65.0% (n = 37) of farmers n Buea and Santa respectively received recommendations from fellow farmers. The sources of pesticides did not statistically differ across the locations. All farmers got their pesticides from pesticide dealers. Fourteen percent (n = 7) and 20.0% (n = 10) of the farmers from Buea and Santa respectively, got their pesticides from buyers of watermelon. The farmers largely adhere to instructions on labels of pesticides containers. The labels on the pesticides packages were in the French and English languages. Fourteen percent (n = 7) of the farmers from Buea and 10.0% (n = 5) of the farmers in Santa had used pesticides with instructions in other languages such as Chinese. Training received on watermelon production show no significant difference across locations. Eighty-six percent (n = 43) of the farmers in Buea and 94.0% (n = 47) of the farmers from Santa had not had any formal training on watermelon production.

Table 5. Sources of pesticides and level of training of farmers

Variable	**Buea (SWR)**		**Santa (NWR)**		**α = .05**
	Frequency	**%**	**Frequency**	**%**	
Who recommend the pesticide					**p<0.05**
Pesticide dealer	50	100.0	50	100.0	
Buyers of watermelon	5	10.0	5	10.0	
Fellow farmers	16	32.0	37	74.0	
Rely on my experience	50	100.0	50	100.0	
Ministry of agriculture	5	10.0	5	10.0	
Source of pesticides					
Pesticide dealers	50	100.0	50	100.0	**NS**
Buyers of watermelon	7	14.0	10	20.0	
Fellow farmers	15	30.0	15	30.0	
Ministry of Agriculture	7	14.0	10	20.0	
Adherence to instructions/labels					
Yes	40	80.0	45	90.0	**NS**
No	10	20.0	5	10.0	
Labels/manuals language					**NS**
English only	0	0.0	0	0.0	
French only	12	24.0	7	14.0	
Others (e.g Chinese)	7	14.0	5	10.0	
Training in watermelon production					**NS**
Yes	7	14.0	3	6.0	
No	43	86.0	47	94.0	

Percentages of 100 watermelon farmers, their sources of pesticides and other related handling practices. Chi square test was used. NS – Not significant. Some percentages may not add up to 100% because some respondents gave multiple answers

3.5 Use of personal protective equipment (PPE) and other constraints

The watermelon farmers adopted the use of different personal protective equipment during pesticide application (Fig. 7). All (n = 50, 100.0%) farmers from Buea and 50.0% (n = 25) of the farmers from Santa used helmets during pesticide application. Thirty percent (n = 15) and 100.0% (n = 50) of the farmers from Buea and Santa respectively, used Wallington boots during their operations. Other PPE used by the farmers include overalls, sucks as gloves, nose guards and goggles.

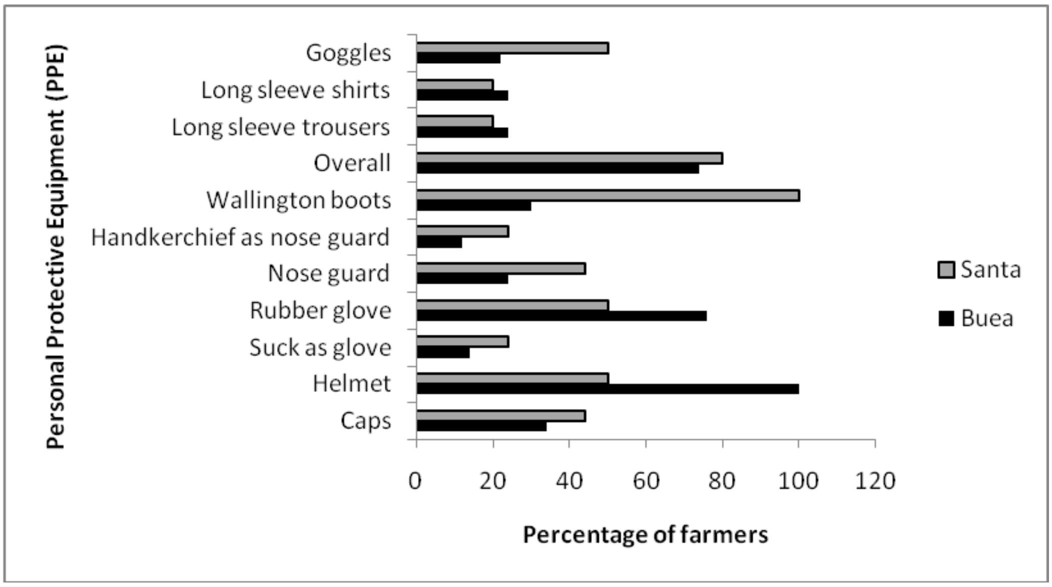

Figure 7: Types of personal protective equipment used by watermelon farmers in Buea and Santa

3.6 Constraints to watermelon production

The farmers in this study projected five major constraints to watermelon production (Figure 8). The constraints were significantly different across locations ($\chi^2 = 23.799$, $P < .0001$). Labour was a major constraints for all the farmers in Buea and Santa. Land acquisition was a major constraints for 90.0% (n = 45) and 50.0% (n = 25) of farmers in Buea and Santa, respectively. Poor market prices were a major problem for 30.0% (n = 15) of farmers from Buea and 70.0% (n = 35) for farmers in Santa.

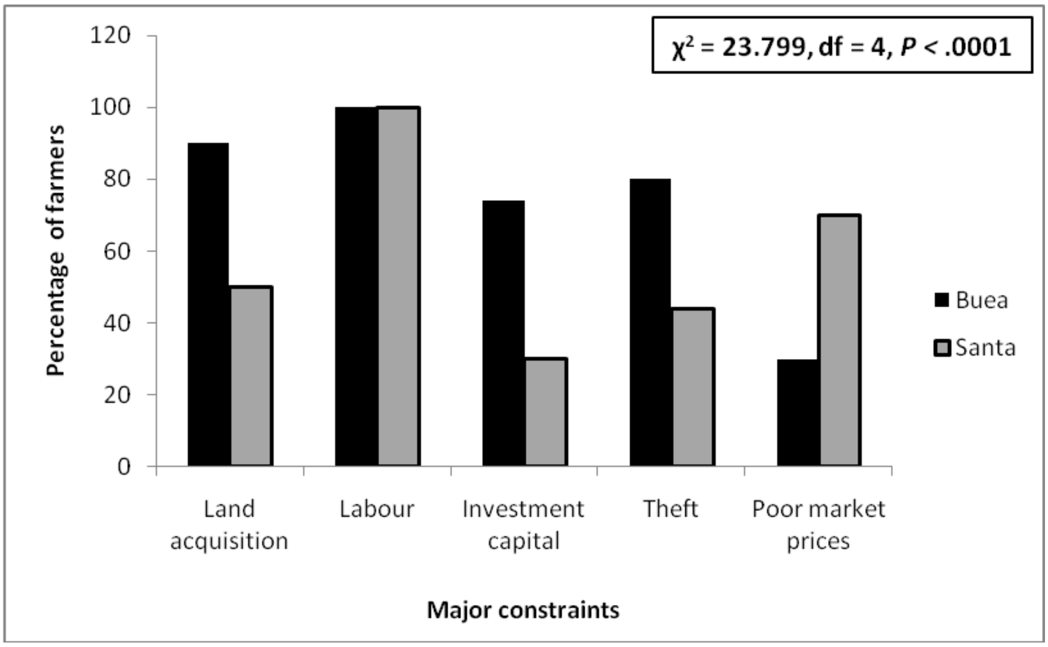

Figure 8. Major constraints to watermelon production in Buea and Santa

IV. Discussion

The results of this study showed that female participation in Santa was twice as much as in Buea. This trend of increased female participation in agriculture in rural communities is a common phenomenon in many parts of the world [17][18] The findings of this study are in concordance with those of [18] who reported a higher women participation in agricultural activities in rural areas than in urban and periurban areas in a similar research conducted in Ghana. The role of women in agriculture is very vital as they engage in many production activities such as land clearing, sowing, weeding, harvesting, transportation, processesing and marketing [17] and in some cases with 100.0% participation [19]. Women, like other people living in urban and periurban areas have many other job opportunities due to urbanization and job dynamism [20]; consequently limiting their engagement in agriculture [21]. Therefore, women engagement could be a positive driver to overall watermelon production. Significant involvement of men in vegetable production reported in this study is in line with the works of [21-24].

Marital status was also statistically different across location. Unmarried farmers in Buea were approximately four times more than in Santa. This outlook does not positively impact agricultural activities as a significantl part of farm labour is provided by family members; given that watermelon production is a semi-industrial operation with much of the labour provided by family and relatives. As a result, farmers in Santa are at a net positive as far as labour is concern as oppose to many of their counterparts in Buea.

The educational status of the farmers in this study varied markedly. Most of the farmers in Santa had only primary education while majority of the farmers in Buea had secondary education, plus a quarter of farmers in Buea receiving tertiary education. Buea is a city hosting the premier Anglo-saxon University of the country and has a Faculty of Agricultural Sciences; thus unemployed graduates are likely to be concentrated in Buea than in Santa; reason why many farmers in Buea had attended tertiary education and some were still students.

About 70.0% of the farmers in Santa and Buea were within the age group of 41 – 60 and 31 – 50 years old, respectively. The number of farmers from Buea within the age group of 20 – 30 years was twice that of Santa. This pattern was also observed by [18] from a related study in Ghana. The youthful population concentration in Buea could be explain by the rural-urban exodus characteristic of many developing countries.

The mean longevity (years) of farmers engagement from Santa was almost four times higher than that of Buea. This is explained by the fact that most farmers in Santa are principally engaged in agricultural activities such as vegetable productiona and animal husbandary. This argument is further buttressed by a larger proportion of farmers in academia (teaching and studies) in Buea compared to Santa.

This study also reveals that farmers from the two locations have particuar preference for two common varieties of watermelon: Wonder and Sweet sensation. It is clear from the results that the buyers of the watermelon were the major influencers of farmers' choice of variety to be grown. The influence of buyers of agricultural produce on agronomic practices has been recorded [18][23][25]. Thus any workshop or training of farmers should be holistic; involving other stakeholders such as the buyers/consumers of the produce and the agrochemical dealers.

Mix farming was significantly higher in Santa than in Buea. This is very characteristic of the nature of farming in rural areas, where semi-industrial scale and subsistence agriculture are common. [26] posited that mixed cropping and multiple cropping practices are adopted by farmers as a means of increased farm income and food security. [27] reported that not only does mix cropping optimize nutrient uptake but it also suppresses soil-borne pathogens and thus play a role in the underlying mechanisns of soil-borne disease reduction. The farmers were productive in both seasons, while dams and rivers served as other sources of irrigation water. This is not uncommon in developing countries with poor infrastructure for agricultural activities.

The mean land area for watermelon production was 4.8 acres/farmer for farmers from Santa, which was approximately twice as much as that of the farmers in Buea. [28] reported that rapid urbanization of Buea has put very immense pressure on land resources and social services. [20] further explained that this pressure on land in Buea municipality is due to the presence of the university of Buea and a whole lot of civil servants who settle and work in the former German Cameroon capital – Buea. They reported that just over a period of fifteen years (2000 - 2014), agricultural land in Buea reduced from 80.0% to 50.0%, making Buea a periurban community if not an urban community. Unlike Buea, Santa remains a rural area with abundant agricultural land.

The farmers were very aware of the pest and disease status on their watermelon crops. This is a very positive step in efficient and effective pest control. One of the tenets for integrated pest and disease management (IPDM) is a proper identification of the pest and disease. Since the pest and disease types do not differ from location to location, it is therefore relevant for exchange of ideas between farmers of both Buea and Santa, on effective management techniques.

Chemical control of pests and diseases was widely preferred by farmers of both regions. This huge preference for chemical control by vegetable farmers had been reported in many parts of Cameroon [21] and other parts of the Africa [22][25][29]. The watermelon farmers did not engage in any form of biological control. Biological control of pest and diseases is a very important component of organic farming. [23] reported that vegetable farmers in Ogun State Nigeria were very keen to organic vegetable production, however, adoption was low due to high cost of running organic farms, which was further compounded by low buying prices of organic vegetables in domestic markets. This might be the reason why watermelon farmers do not invest in organic farming.

Twice as many farmers in Buea than in Santa applied pesticides on calendar bases. This practices has been reported by many other researches [18][25][30][31]. Calendar base spraying of pesticides is costly and often lead to high unacceptable pesticide residue levels in vegetables and fruits [29][32], high cost and killing of non-target organisms such beneficial insects [33] Spraying the field based on pest damage level or forecast is highly recommended as it is the case with most farmers in Santa. Pest, diseases and soil fertility needs are compounding factors in watermelon production [34]. It was therefore not surprising that the farmers in this study all used pesticides and fertilizers in order to ammeliorate and increase production.

Mixing pesticides before application has been reported from vegetable farmers in many parts of the Cameroon [21][35] and in Africa [18][22][25] and some parts of the world [36].

NPK, Urea and SOA were traditionally used by watermelon farmers for soil nutrient improvement. Worthy of note is that farmers from Santa by far used organic manure (poultry manure and cowdung) for soil nutrient suppliment. Use of organic manure is common in the western highlands of Cameroon [37] probably due to the fact that animal husbandry is also very common in this area. Organic manure should be used more often; not only is it cheaper than chemical fertilizer, but it also improves soil drainage capacity and aeration and soil microorganism fauna [38] The farmers principally got their agrochemicals from agrochemical dealers. Some of these chemicals came from state extension workers. Such collaboration with the state and farmers are relevant as this provides not only incentives but also some sort of motivation. The farmers in Buea did not seem to rotate the type of fertilizer used over time unlike their counterparts in Santa. [39] posited that changing fertilizer types overtime especially incorporating organic manure increases nutrient availability, soil organic carbon (SOC), which acted as buffer against soil acidification (pH > 5) resulting from N-containing inorganic fertilizers.

The farmers in this study used pesticides, mainly insecticides and fungicides. The farmers also used herbicides and nematicides. [18] and [21] reported that the use of pesticide is not uncommon with rural, periurban and urban vegetable farmers. The high use of insecticides and fungicides can be explain by high population of thrips, aphids and grasshoppers and an assorted array of diseases associated with watermelon fields [34]. [40] recorded a wide spectrum of insect pest attacking watermelon from planting to leafy stage, and flowers to the fruits. Not only is there a broad spectrum of pests and diseases in the watermelon field, but also the ravaging effect is also present in both growing seasons of watermelon [40], thus necessitating the need of the incessant use of pesticide. The act of mixing agrochemicals before spraying is not unique to the farmers of this study. [35] recored similar behaviour among vegetable farmers in Ghana. [22] recorded that vegetable farmers in Ogbomos State (Nigeria) also practised some sort of agrochemical mixing before application. Farmers practice this mixing methods mostly in order to save time. This may be the reason why insecticide and fungicide mixtures were very high in Buea, whose farmers must save time since they were involved in other activities such as teaching, studies and trading. The farmers in this study got their information on pesticides use from many sources; pesticide dealers, buyers of their produce, fellow farmers, relied on experience and extension workers. There was a significantly higher farmer-farmer collaboration between farmers in Santa than in Buea. This could be due to the close nature of the farmers living in Santa area. Also, Santa being a rural area, it was likely that the farmers would speak the same or similar languages and engage in many cultural and social activities that would bring them even closer together than their counterparts living in Buea which is periurban community – cosmopolitan in nature and likely composed of people with varied social and cultural interests. Interestingly, [41] and [23] recorded that more than half of the farmers (n = 485) in their study in Nigeria got their information on pesticide use from radio and television. The sources of pesticides differed across locations. The farmers got their pesticids from pesticide dealers, buyers of their produce, fellow farmers and extension agents. These sources of pesticides have also been recorded in other related studies [18][21][23].

The farmers largely adher to the instructions prescribed on the labels of pesticide packages. This may be due to the fact that the instructions were written in French and English; the two official languages of Cameroon. However, some instructions were also written in non-official languages such as Chinese.

Majority of the farmers had no formal training in watermelon production. The trend is very common in many countries [35]. Knowledge on crop production is mostly learned from friends and or passed on from generation to generation. The farmers adher to very minimal use of PPE during pesticide application. In some cases, they used what they had to improvise the rather sophisticated recommeded PPE. Sucks, caps, handkerchiefs, long sleeve shirts and trousers were largely used during pesticide application by farmers from both regions.

Overall, the farmers had 5 major constraints to watermelon productin. Labour was a major constraint for all farmers in both localities. Labour was fundamentally a major problem because agriculture in most developing countries is still very human-labour intensive with little or no mechanization. This was further compounded by the fact that young people with more energy, were not engaging enthusiastically into agricultural activities. Land acquisition was twice as much a problem in Buea than in Santa. This is very much inline with the arguments of [20] who posited that rapid urbanization of Buea is putting pressure on agricultural land. Poor market prices severely plagued the farmers in Santa compared to their counterparts in Buea. Farmers in Santa have to wait for large-scale buyers to buy their produce and then sell in major cities. These large-scale buyers often dictate the prices of the produce, as such leaving the farmers with very little or almost an insignificant bargaining power. On the other hand, market prices was not a major problem to the farmers in Buea, who could sell to large-scale buyers and also take advantage of the high urban population next door and easy access to many urban and peri-urban markets littered all over the Buea municipality. Theft was a bigger problem for farmers in Buea than in Santa. This is likely due to the close contact of farms and urban settlements; thus encouraging theft and other encroaching activities. Investment capital was also far more a major problem in Buea than in Santa. Buea being a periurban metropoli would definitely have a spike in prices for almost everything especially land and labour compared to Santa. Investment capital was not a major problem for farmers in Santa compared to those in Buea. This may be as such as because of the excellent farmers collabrotaion through cooperatives; prevalent in the Western Highlands of Cameroon [14].

V. Conclusion

Watermelon production in Buea and Santa and the entire Cameroon has huge potentials for job creation and income generation should appropriate measure be taken to ammeliorate the crop production situation. Experience in the cultivation of watermelon played a fundamental role in the success of the farmers in Santa. Female involvement in the production process could be a positive factor in poverty aliviation and improved nutrition for the family. Generally, farmers in Santa adher more to good agronomic practices than their counterparts in Buea, especially in areas of cultural control of pest and diseases, pesticide and fertilizer application. These and more are the lessons that farmers from Buea can learn from farmers in Santa irrespective of other inherent problems. A schematic diagram has been provided (Fig. 9): summarying the learning needs and knowledge flow for improved watermelon production in Buea and Santa.
production in Buea and Santa.

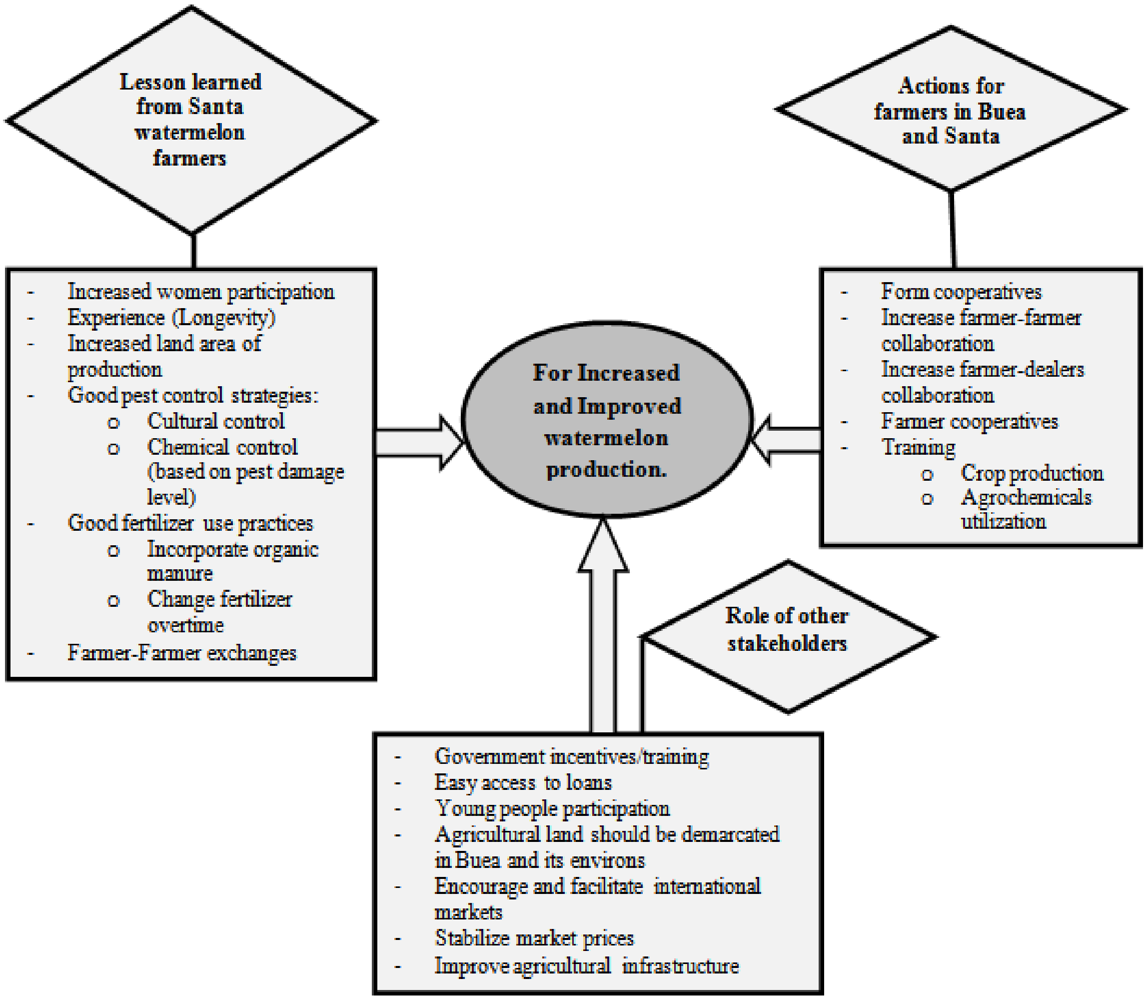

Figure 9: Schematic representation of learning needs and knowledge gap for improve watermelon production in Cameroon.

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