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Article

Small Scale Farmers' Indigenous Agricultural Adaptation Options in the Face of Declining or Stagnant Crop Yields in the Fako and Meme Divisions of Cameroon

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Abstract: Research has proven that, at a national scale in Cameroon, arable crop production is either declining or stagnant. In the face of these trends, governments, local and international organizations, communities and peasant farmers have developed adaptation options to sustain arable production and reduce poverty. Given this general context, and based on population perceptions and four study sites in the Southwest region of Cameroon, this study aims at verifying current trends in arable production and farmers' adaptation options based on their indigenous knowledge. These analyses are based on the administration of 200 questionnaires and two focus group discussions (FGDs). The data were analysed using SPSS version 20 in which frequencies, percentages and means were calculated. In addition, the chi-squared statistical test of goodness of fit was calculated and the stated hypothesis was validated accordingly. The FGDs were analysed through verbatim transcriptions and with the aid of the context analysis software, Wordstat 7. The results show that current yields (2010–2014) in all the study sites are declining due to deforestation, poor governance, inadequate access to farm inputs such as fertilizers, increased economic opportunities elsewhere and a breakdown of cultural practices, while 10 years (2000–2010) previously, they had been increasing. It has also been found that the main adaptation options/coping mechanisms reported by the respondents in order of highest frquencies are: expansion of farm size, help from relatives and dependents that live on the farm, supplemental occupations or livelihood diversification and usage of organic fertilizers. From the chi-squared test, the alternate hypothesis that, "there is some difference between population proportions for different adaptation options or coping mechanisms" is validated.

Keywords: adaptation; crop yields; expansion of farmland; supplemental occupations

1. Introduction

In Cameroon, the agricultural sector and related food processing activities account for about 50% of export earnings, contribute about 30% to the GDP and employ between 70%–80% of the population [1]. The agrarian population in Cameroon is made up of essentially small-scale peasant farmers and their family members who make up about 70% of the agricultural population [2].

The majority of farmers in Cameroon are small-scale peasant farmers and they are responsible for the production of about 80% of the country's food crops. In the face of an increasing population, the use of farm inputs that are not environmentally sustainable, and wide-scale agricultural and forest land use changes, food crop production trends seem to be uncertain or rather stagnant as studies report that projected/expected needed crop production is often above actual production [3,4]. A study by Epule *et al.* [4] argued that, between 1975 and 2005, there were 20 years during which actual cereal production in Cameroon were persistently below projected/expected needed cereal production levels. Yengoh *et al.* [5] verified the role of land management practices and the socio-cultural properties of small-scale farmers in establishing differences in crop yields. In addition, Epule *et al.* [6] verified the vulnerability of experiencing food shortages along gender and poverty lines.

Several authors have argued that, as in most sub-Saharan African countries, Cameroon is currently experiencing declines or stagnation in food production at a national scale [7,8]. Some studies have attributed this decline to poor soil nutrient conditions [8–10], while more recent empirical and model based analyses have attributed the declines to global environmental change related variables such as population growth and the inherent expansion of agricultural land through forest clearance/deforestation, which results in reduced soil organic carbon and nitrogen, essential elements in crop growth [7,11]. Other potential causes of the decline are: poor governance, inadequate access to farm inputs such as fertilizers, increasing economic opportunities elsewhere, and a breakdown of cultural practices. A lot of efforts are being made to increase crop yields and reduce food insecurity. One such effort is geared towards adjusting food production systems to adapt to the environmental changes through various adaptation strategies.

Agricultural adaptation requires a consideration of both human and physiographic challenges that are responsible for environmental change in specific contexts. In the context of this study, this has to do with the physiographic and human oriented drivers of food insecurity listed above. In as much as indigenous knowledge remains vital, dealing with the drivers of food production stagnation will also involve comprehensive and dynamic policy changes [12]. Climate Smart Agriculture (CSA) offers an integrative approach to adaptation within the context of agriculture that involves services to farmers and farm activities with the intention of creating greater resilience of farming systems in the face of environmental change and reducing the environmental foot-prints. CSA can be regarded as a set of integrative approaches that are used to increase agricultural productivity while at the same time making agriculture sustainable. CSA is not a set of practices but a set of approaches that must be context-specific. CSA was coined by the Food and Agricultural Oranization of the United Nations (FAO) in 2010 following the Hague conference on food security, agriculture and climate change. CSA aims to: increase food production, increase the resilience of farming systems to environmental change and increase the sustainability of agricultural systems through reduced Green House Gases (GHGs) and environmental foot-prints emanating from agriculture. The options for CSA must be like the word, "SMART" itself *i.e.*, S for Specific, M for Measurable, A for Attainable, R for Relevant, T for Time-Bound (Figure 1). CSA often involves two main elements: (1) services to farmers such as policies, financing and institutional arrangements and (2) land management options that aim at conserving ecosystem services. As such, the prospects of CSA for scientific management will be based on these two elements.

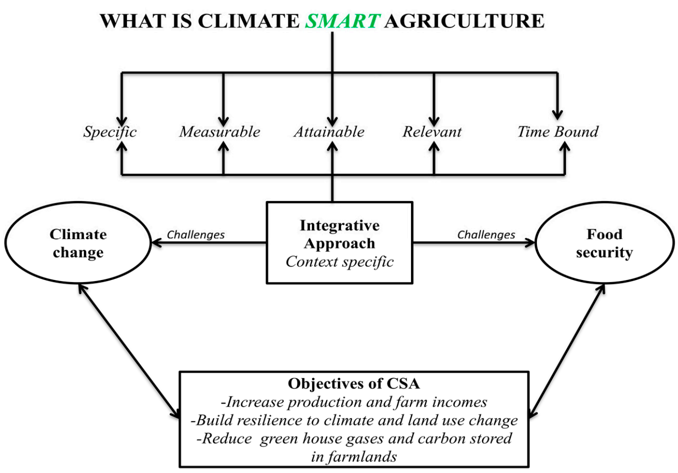


Figure 1. Main components and scope of climate smart agriculture.

The main purpose of this study is to determine whether small-scale farming crop yields are declining or not and to verify the existing adaptation options used based on indigenous knowledge in the specific study sites. However, this study has three main objectives: (1) to verify the perceptions of the local peasant farmers on existing trends and projections as to whether crop yields were increasing, declining or stagnant between 2010 and 2014 (current yields) and in the past decade (2000 and 2010), (2) to verify the perceptions of the local peasant farmers with respect to current indigenous adaptation options used. Indigenous adaptation here reflects the different adaptation options that are used by the local farmers, and (3) to discuss the areas of CSA that can be adopted by the local farmers in establishing meaningful adaptation options in the study area. To the best of our knowledge, this is the first time such analyses have been performed on these specific study sites and at this scale. As noted above already, there are studies that have already identified that at a national scale there are food production declines, but these have not been verified in the different agro-eco-regions of Cameroon. As such, this finer-scale analysis fills in a major gap by identifying whether there are variations in yields, what the drivers of this are and whether they vary across space, and most importantly what this means for adaptation (*i.e.*, how context-specific does adaptation need to be?).

2. Materials and Methods

2.1. Study Area

This study was conducted in the Fako and Meme divisions of the Southwest Region of Cameroon. In each of these divisions, two research sites were selected. The first research site in the Fako division is called *the Bonjungo court area*. This research site is located at 4°1″12′ N, 9°11″24′ E (Figure 2). *The Bonjungo court area* has a population of about 11,000 people. The second site in the Fako division is called *Lower Muea*. It is located at 41°9″36′ N, 9°13″48′ E (Figure 2). Lower Muea has a population of about 8,000 people. Both sites in the Fako division have several similarities for which they were selected: (1) they are both located on the foot-hills of Mount Cameroon where there are volcanic soils [13,14]; (2) they both have an equatorial climate which is hot, humid and has persistent rainfall all year round. They have mean annual temperatures of about 18.6 °C and an annual rainfall of about 2815 mm. The driest month is December with about 29 mm of rainfall and the wettest month is August with about 488 mm of rainfall. The warmest month is March with temperatures of about 19.7 °C while the coldest month is July with temperatures of about 17.3 °C; and (3) about 80% of their population is comprised of small-scale farmers and their families who depend entirely on agriculture for their livelihoods.

In the Meme division, the first research site is called *Bole Bakundu*. This research site is located at 4°38″24′ N, 9°43″48′ E (Figure 2). *Bole Bakundu* has a population of about 4,000 people. The second site in the Meme division is called *Marumba one*. It is located at 4°37″48′ N, 9°5″24′ E (Figure 2.). *Marumba one* has a population of about 2,000 people. Both sites in the Meme division have several similarities for which they were selected: (1) they are both located on the far eastern slopes of Mount Cameroon where there are sandy-loam soils [13,14]; (2) they both also have a tropical climate which is hot, humid and with a good deal of rainfall. They both record mean annual temperatures of about 25 °C and an annual rainfall of about 864 mm. The driest month is January with about 0 mm of rainfall and the wettest month is August with about 247 mm of rainfall. The warmest month is April with temperatures of about 29.3 °C while the coldest month is December with temperatures of about 22.2 °C; (3) about 85% of their population is comprised of small-scale farmers and their families who depend entirely on agriculture for their livelihoods.

In spite of the similarities listed above, the Fako and Meme divisions have some major differences. Socio-culturally, the Fako division is inhabited by the "*Bakweris*" who speak the "*Mokpwe*" language, while, in the Meme division, we have the "*Bakundus*" who speak the "*Oroko*" language. Economically, the Fako division is more buoyant as it hosts Cameroon's only oil refinery while the Meme division lags behind with mainly 'small-scale businesses and farms'. The Fako division also host part of the coast of

Cameroon while the Meme division is landlocked. Climatically, the Fako division has an equatorial climate with more rainfall of about 2815 mm per year, while the Meme division has a tropical climate with lower annual rainfall of about 864 mm.

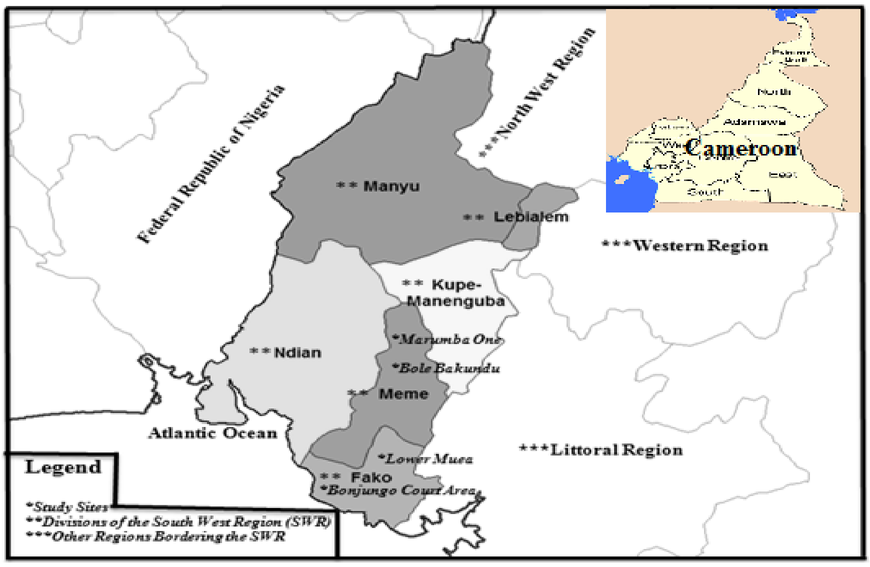


Figure 2. Location of four study sites in the Southwest Region of Cameroon.

2.2. Data Gathering

Two focus group discussions (FGDs) were held with household heads. One was held in *the Bonjungo court area* (comprised of 8 females and 7 males) and the other was held in *Bole Bakundu* (comprised of 5 females and 10 males). Each FGD was comprised of 15 small-scale farmers who were also household heads and were involved in crop production. The participants were invited to participate in the discussions through their local chiefs. The FGDs were conducted by the researcher and three research assistants. All the research questions were read out and explained to all the participants. In cases where a participant did not understand because of language barriers, research assistants who speak *Mokpwe* and *Oroko* languages (local languages spoken by the *Bakweris* and *Bakundus* of the Fako and Meme divisions respectively) provided clarification. Participants in the FGDs had to be full-time farmers, they had to be involved in food crop cultivation, they had to be willing to permit the researchers to visit their farms and they were free to opt out at any stage of the discussion. The participants were also asked to give reasons for their choices of adaptation options during the FGDs. The key themes discussed during the FGDs were: (1) knowledge of the state of arable production in the study site (declining, stagnant or increasing); and (2) knowledge of and use of various adaptation options to cope with crop yield stagnation or decline (Table S2).

In addition, a random survey of 200 small-scale farming households was conducted. Since this study has four research sites, 50 questionnaires were administered in each research site. The selection of 200 small-scale farmers in this study was guided by the following logic: (1) based on the 200-respondent sample size, the null hypothesis was rejected and the alternate hypothesis that supports the view that some adaptation options were more important than others was validated, and this means the sample was reliable and (2) based on previous information about the respondents, such as the fact that about 80% of the population living in the study area are small-scale farmers. To test the validity and reliability of the questions, the questionnaires, were pre-tested on three respondents at each research site to ensure that the questions were properly formulated to acquire the appropriate population perception data. In cases where some questions were ambiguous, unclear and vague, the questions were restructured to improve clarity. The questions evaluated the following themes: (1) respondents' age group, gender, level of education, number of years of farming experience, annual income and the number of family members that live and work on the farm (Table S1); (2) respondents' perceptions on whether their yields are rising or declining; (3) respondents' knowledge of adaptation options against arable crop yield stagnation and decline (Table S2).

2.3. Data Analysis

The FGDs were analyzed using verbatim transcription and Wordstat 7 context analysis software (Morman Peladeau of Provalis Research, Montreal, Canada). Context analysis enhances the identification of the key themes arising from the FGDs. The Wordstat 7 software was used because of its ability to identify themes or relationships in verbatim responses, focus group transcripts or other text sources. It involves four main stages [15]: (1) identification of the main themes from the FGDs; (2) attributing different codes to the main themes; (3) classification of responses under the main themes identified; and (4) integration of themes and responses into narratives.

In addition, various statistical tools were used to analyze the quantitative data using SPSS version 20. Specifically, the statistical tools included frequencies, means and percentages of all the variables under investigation. The reliability of the results on the various adaptation options used by small-scale farmers was tested with the use of the chi-squared (χ^2) statistical test of goodness of fit of the sample data to the uniform population distribution for the adaptation options. A 0.05% or 5% significance level was adopted while the degree of freedom was computed by fomula (1):

$$\text{Degree of freedom} = n - 1 \quad (1)$$

i.e., (18 − 1 = 17), where *r* was the number of proposed adaptation options. The hypotheses that were tested were as follows: the null hypothesis (H_o) was that the population proportion were equal for each adaptation option or coping mechanisms. In other words, there were no differences in the significance between different adaptation options. The alternate hypothesis (H_1) was that there were some differences between population proportions for different adaptation options or coping mechanisms, *i.e.*, some adaptation options or coping mechanisms were more important than others. As a rule, if the calculated χ^2 was higher than the critical table value, the H_o was rejected and the H_1 was accepted. On the other hand, if the calculated χ^2 was lower than the critical table value, the H_o was accepted and the H_1 was rejected. Note that the order of importance of the various adaptation options was descriptively judged by the ranking of frequencies based on only the magnitude of the various frequencies of the adaptation options with no other statistical bases for ranking.

3. Results

3.1. Socioeconomic and Demographic Characteristics of the Respondents

Six main socioeconomic and demographic characteristics of the respondents were evaluated. Overall, of the 200 small-scale farmers, 54% (108) were male while 46% (92) were female (Table S1). According to the FGDs, when both men and women or couples were involved, the male in the couple was still considered as the main farmer because men are considered the main bread winners of their families while the women either accompany their husbands to work on the farm or stay at home to take care of children and perform other domestic chores. This distribution brings in the argument that when it comes to issues of ownership and access to land and its resources, men have both ownership and access while women in most cases may be granted access at the men's discretion. Women in coupled relationships do not have unlimited ownership and access to land and its resources.

In terms of the age groups of the small-scale farmers, the active population age group of between 40–45 years involved 63 respondents, which represents 31% of the total, while the >60 years age group recorded the smallest number (4.5% or 9% respondents) (Table S1). Results from the FGDs showed that the >60 years age group was essentially dominated by the aged who were no longer actively capable of carrying out sustained farming due to a reduction in their strength. According to the FGDs, the predominantly aging population also serves as a major constraint in adopting various modern adaptation options because the aged are generally less likely to learn new techniques, and talk less of acquiring new knowledge on how to adapt their farming systems to environmental change.

Regarding the level of education, the results showed that a majority of the respondents (56% or 112%) had achieved only primary education, which represents about 6–7 years of schooling in total. The 21–25 years of farming experience was the lead category with 23.5% or 47% of the respondents (Table S1). This translates into an average of about 21–25 years of working experience for most farmers in the study sites (Table S1). According to the FGDs, the limited level of education is often a constraint in the adoption of advanced or modern techniques of adaptation; this means that the farmers depend considerably on their own indigenous knowledge in adapting to yield declines and stagnation.

In relation to annual income, the <240,000 Franc CFA (Communaute Financiere Africaine) income group recorded the highest level with 45% or 47% respondents. The generalized observation was that there were fewer respondents as higher income levels were attained (Table S1). According to the FGDs, this helps explain the fact that farmers are generally poor and have limited access to expensive farming inputs and this often sets limits on the extent to which the farmers are able to adapt to stagnation or declining yields.

Finally, in terms of the family members who live and work on the farm, the results showed that on average, between three and five persons live and work on the average farm. This is reflected in 45% or 108% respondents who were recorded in this category (Table S1). From the FGDs, it is observed that, in most of the study sites, family labour was a key production input as often the farmers depend on the assistance they get from their wives and children in order to be able to meet production needs. The ranges presented here include all those living and working on the farm including the farmers, their wives, children and other dependents. The use of family labour as an option of adaptation to stagnating and declining arable yields was a common indigenous adaptation option as revealed during the FGDs. Most famers depend entirely on their spouses and children and other dependents in obtaining the required farm labour.

3.2. *Status of Current and Past Arable Crop Production Yields and Adaptation Options in all Four Study Sites*

Current arable crop production yields in the four study sites were observed to be characterized by a declining trend. The period described in this study as the current arable production yield period depicts the recent past between 2010 and 2014(<5 years). The decline was evident, as out of the 200 respondents in all four study sites, 178 said that their current yields were declining, while 8 said their current yields were stagnant, 14 said their current yields were increasing, none said they were unpredictable, none said they had no idea and none made any other comment. In terms of yields during the past decade, 154 respondents said they were increasing while 46 said they were declining, none said they were stagnant, none said they were unpredictable, none said they had no idea and none made any other comments (Figure 3a,b). Again, the past decade describes arable yields between 2000 and 2010.

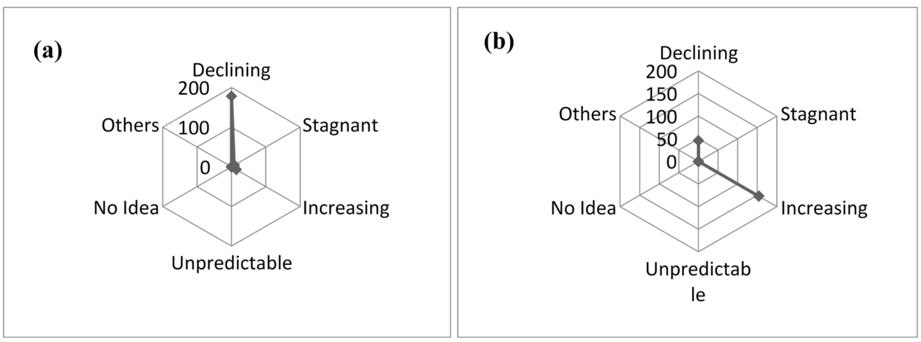
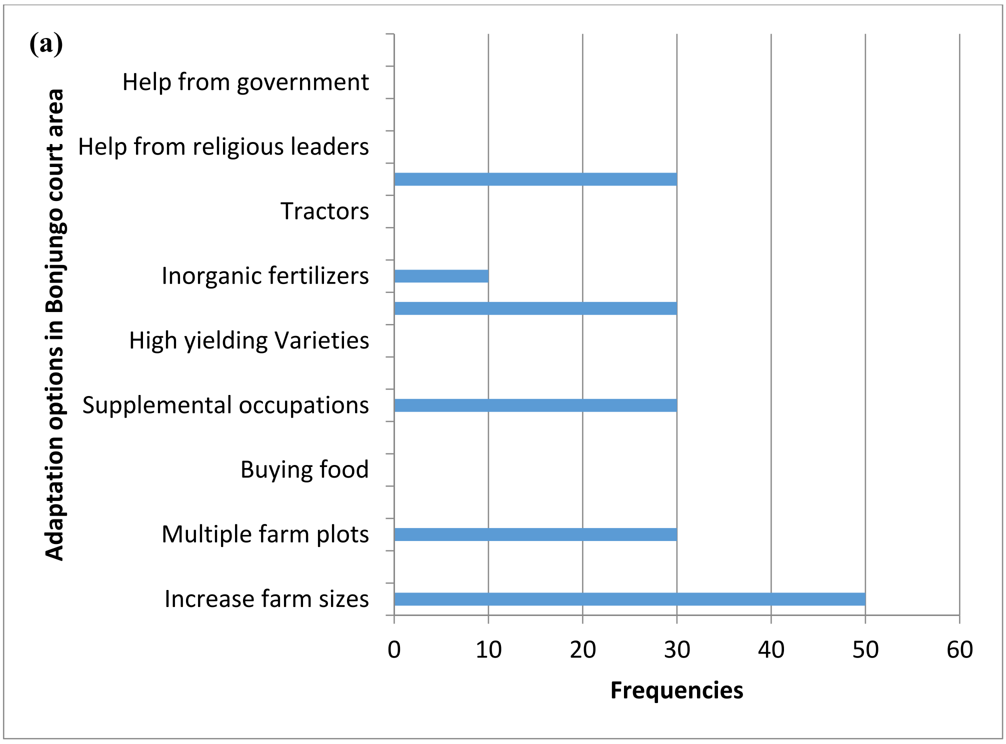


Figure 3. Respondents' perceptions of the status of (**a**) current and (**b**) past yields in all four study sites.

In general, 18 adaptation options were evaluated in this study. These options were organized into two main categories as follows: problem-solving adaptation mechanisms and social-support adaptation mechanisms (Table S2). The problem-solving adaptation mechanisms are adaptation options that are based on concrete efforts at adapting farming systems and personal decisions by diversifying farm inputs, modifying farm sizes, relocation of farms, ownership of multiple farms, buying of food, supplemental occupations, and additional hours of work, *etc.* The social-support adaptation mechanisms are based on help from various governance structures ranging from family labour, help from religious and tribal authorities to policies of government, Non Governmental Organizations (NGOs) and those of international organizations. Because of multiple responses to the questions asked, each study site records a frequency of more than 50 and the total for all four sites was also more than 200. In other words, one respondent can select more than one adaptation option in responding to a question.

Generally, the results showed that the dominant adaptation option used in all four study sites was to increase farm size. The increase in farm sizes described here is linked to the deforestation of existing forest to create new farmlands and not the purchase of other farmers' farmlands. In total, 192 out of 200 respondents selected this option as their main method of trying to enhance food production. All 50 respondents in the *Bonjungo court area, Bole Bakundu and Marumba 1* also selected increase in farm size as the main adaptation option. In *lower Muea*, 42 out of the 50 respondents selected increase in farm size as their main adaptation option (Figure 4a–e). In order of importance and based on frequency of responses, the other adaptation options and their ratings are: help from relatives (134), getting involved in supplemental occupations (130) and the use of organic fertilizers (116).



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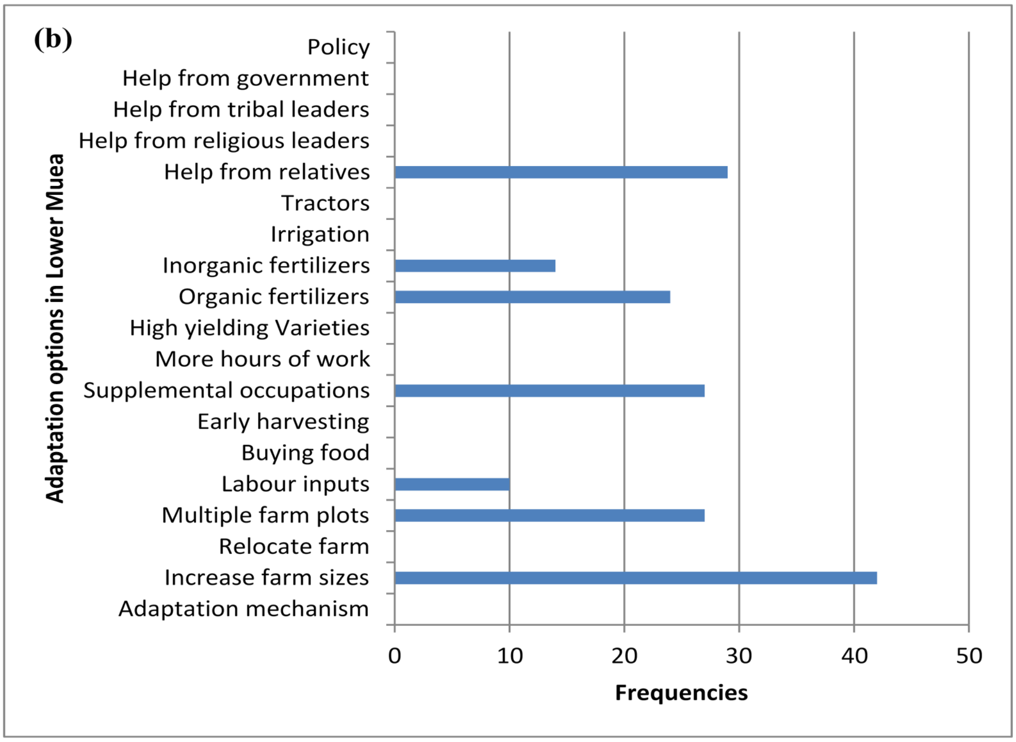

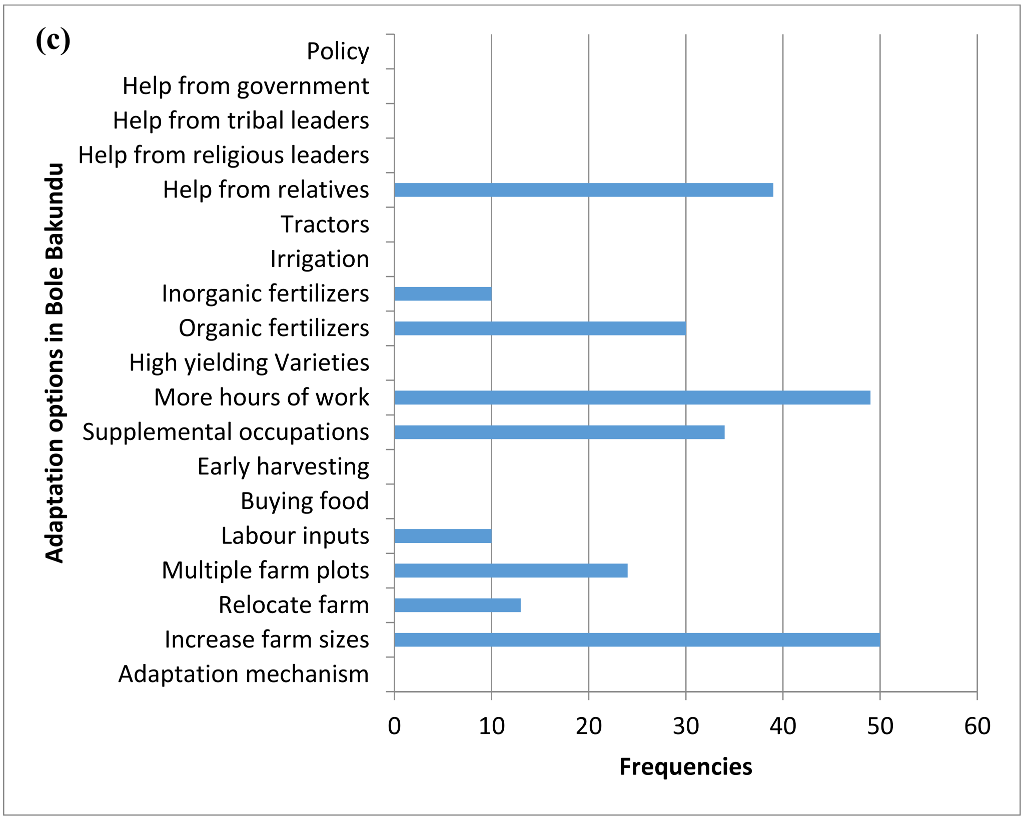

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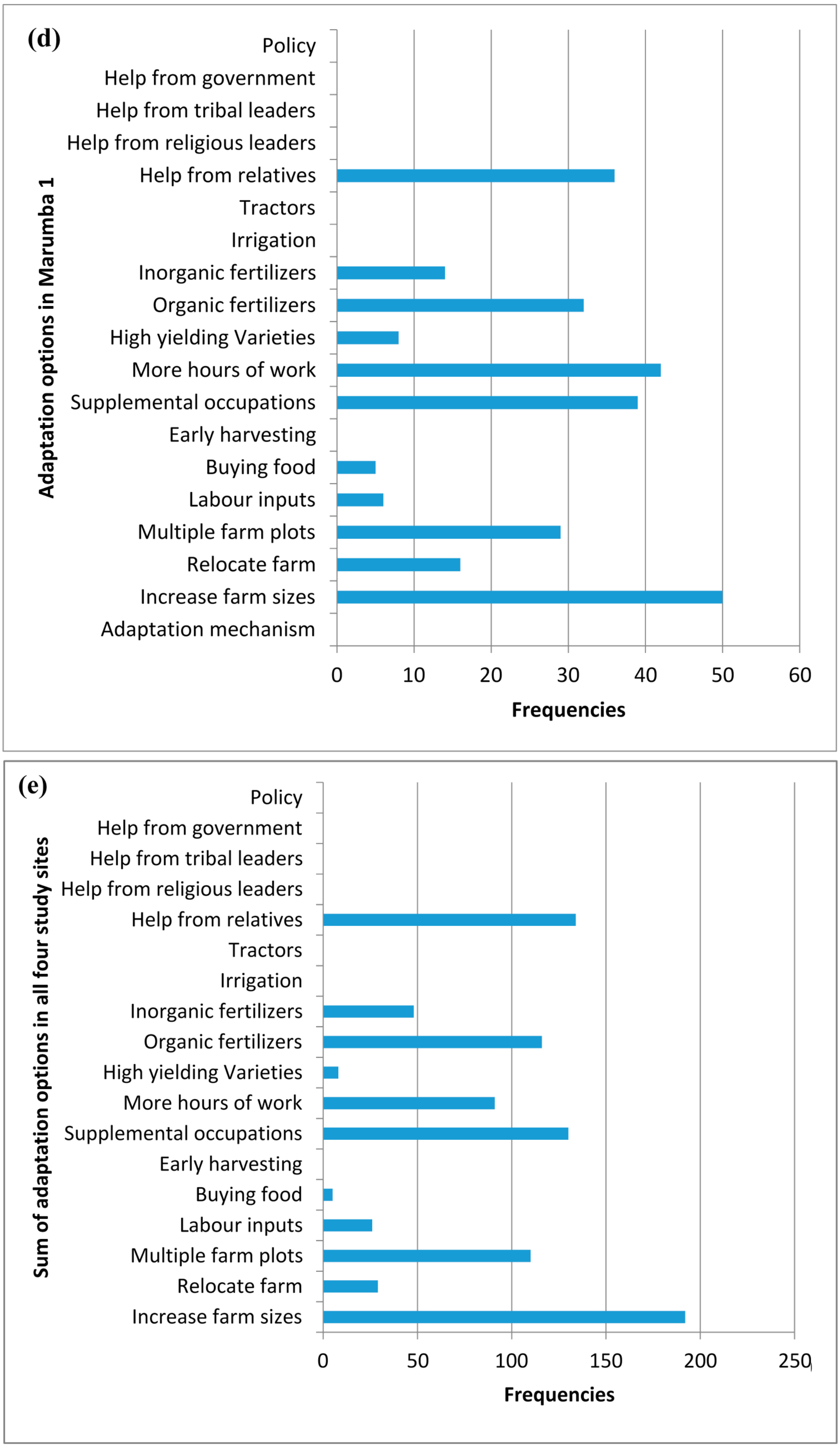

Figure 4. Population perceptions of adaptation options to enhance food production in (**a**) *Bonjungo* (**b**) *Lower Muea* (**c**) *Bole Bakundu* (**d**) *Marumba 1* and (**e**) all study sites.

From the χ^2 analysis, it can be observed that a calculated χ^2 of 8283.9 was obtained at a degree of freedom of 17 and a level of significance of 5%, and a table χ^2 of 27.59 was obtained. The alternate hypothesis (H_1) that there were some differences between population proportions for different adaptation options or coping mechanisms, *i.e.*, some adaptation options or coping mechanisms are more important than others, was accepted while the null hypothesis (H_o) was rejected. As a rule, if the calculated χ^2 is higher than the critical table value, the H_o is rejected and the H_1 is accepted. This is quite understandable because, in reality, some adaptation options are more important than others as seen in the results above. For example, in all the study sites, increase in farm sizes stands out as the most important adaptation option. This is followed by help from family members, supplemental occupations and the use of organic fertilizers.

4. Discussion

The assertion that arable production is declining in the current study sites is consistent with several other studies. Faced with increasing population, less sustainable farm inputs, and wide-scale land use changes in the forestry sector, Cameroon has witnessed crop production stagnation as projected needed crop production is said to be above actual production [3,6]. A study carried out in the drier north of Cameroon by Epule *et al.* [6] argued further that, between 1975 and 2005, there were 20 years during which actual cereal production was persistently below projected needed cereal production. Following the FGDs, the common reasons for the decline in yields in all four study sites included: wide-scale deforestation through slash and burn fires, out migration of working populations to urban areas, lack of access to farm inputs such as inorganic fertilizers, limited understanding of how to valorize organic fertilizers, and inadequate implementation of government policies protecting the agricultural sector.

In most of Africa, access to basic farm inputs is often scarce due to poverty, and farmers tend to resort to farmland expansion as a means of increasing their yields. It is often believed that the more land that is brought under production, the greater the yields. While this is true to a certain extent, it is also common knowledge that, at a certain threshold, the more new land that is brought under production, the more likely is the potential to observe diminishing returns to scale. To make things worse, this option will soon become obsolete due to large scale deforestation in favour of farmland, and the fact that less and less land is becoming available in most of Africa for continued arable production expansion. In the related literature, it has been argued that the expansions of permanent croplands as well as pasture land are common strategies used in adaptation to food production declines. It is suggested that when crop and pasture land areas increase, food production and supply will increase since more hectares will brought under cultivation [7]. Using statistical approaches, Epule *et al.* [6] have shown that there is a perfect positive correlation between food production in Africa and the expansion of permanent cropland; they obtained a correlation coefficient of 0.86 and a coefficient of determination of 0.87 between food production and cropland expansion. The latter study states further that, in Africa, permanent cropland increased by 64% (14,868 thousand hectares), from 27,122 thousand hectares in 1961 to 41,990 thousand hectares in 2000. This reasoning has been supported further by arguments that African food policy has for a long time been anchored on the expansion of farmland [16]. Rosegrant and Cline [17] argued that the expansion of agricultural land is one means of boosting up production that is sufficient in meeting rising demands for food. The process of increasing land in order to cultivate more crops is not necessarily sustainable environmentally. This is why it has been argued that arable and permanent cropland expansion in Cameroon to enhance crop production has been described as the second most viral cause of deforestation [17].

It has also been verified that the expansion of farmland is often associated with increases in production in the short run and reductions in the long run. For example, an empirically grounded model, based on a study by Epule and Bryant [18], found that the expansion of maize production land in Cameroon led to increased maize production in the short run but a reduction in the amount of maize produced in the long run. They argued that expansion of farmland in the short run provides more land for cultivation but in the long run, the area that has been deforested for this expansion becomes susceptible to all types of erosion and low soil nutrient storage and consequent reductions in soil organic carbon and nitrogen. While most farmers continue to depend on expanding farmland to increase production in most of Africa, this method of adapting agricultural systems to declines in production has been presented in many studies as one of the main problems of food security in Africa [17–21]. To make a bad case worse, the prospects of expanding farmland further in most of Africa are gradually diminishing as less and less land is becoming available [17]. In Africa, Asia and Latin America, 96% of forest area loss is as a result of agricultural expansion [20–25]. Farmland expansion stands out as the most important indigenous adaptation option in all the four study sites considered in this study. This can be explained by the fact that the local farmers do not have access to other methods of expanding production such as high capital intensive equipment and inorganic fertilizers and therefore depend on the only available resource; that is, land to produce more. As presented already, it is believed that the more land you use for production, the higher your yields, but, in the long run, such expansion would rather reduce production due to inadequacies in soil organic carbon and nitrogen and high levels of erosion.

In addition, farmers in Africa also depend a lot on family labour to enhance production. The average family is composed of the father, the mother and at least three to four children. The more members a family has, the more the family is said to have assets because family labour is often a major source of agricultural labour in mainly poor communities in the developing world in which access to modern techniques of adaptation such as tractors and high yielding varieties are lacking. Unfortunately, the productivity of family labour is often limited in that it can often increase yields only to a certain threshold beyond which stagnation results. This is one of the reasons why, in spite of these measures, the study sites still experience stagnation in production. Djurfeldt *et al.* [17] noted that food production in most of Africa is labour intensive and capital extensive, meaning most farmers in Africa depend on the labour of their family members or dependents due to limited access to capital equipment such as tractors.

Many of the farmers are involved in other activities aside from crop production in a bid to absorb the shocks associated to declining yields. These have been described as supplemental occupations. In the study sites, some farmers have resorted to a diversification of their livelihood by not depending only on crop production. This option is good because during periods of stagnation or declines in yields, the farmers can rely on their supplemental occupations. Common options used here as declared during the FGDs include the rearing of livestock such as cane rats, goats, rabbits and poultry. Others depend on small businesses such as sole proprietor shops in the neighbourhoods that sell basic household utilities. Supplemental occupations are very important in various natural resource management decisions. In the literature, it has been argued that one way of making sure that communities dependent on natural resources absorb the shocks in cases of declines in their resources is through the diversification of livelihoods or integrating other activities into their main activities. For example, gatherers and farmers may diversify their livelihoods by rearing cane rats, goats and rabbits that can supplement the income lost from their regular activities as gatherers and farmers. In forestry, for example, one way of stopping the indigenous population from cutting trees is through supplemental occupations or diversification of livelihood activities through the provision of credits, cash or other incentives that can help farmers take up tree crop planting as a means of subsistence. In this way, they do not have to resort to logging to satisfy their basic financial or fuel wood needs [26–31]. Diversification of livelihoods—also called livelihood planning—has been described as one of the most important socio-economic methods of absorbing the shocks involved in environmental resource decline by Le *et al.* [32]; it reduces the degree of dependence on farming and gathering by providing alternatives for the local populations. The diversification of livelihoods also involves a more systematic change in resource allocation such as targeted diversification of production systems and livelihoods [32,33].

In terms of the use of organic fertilizers, many farmers use this as a natural system of adaptation in the face of declining yields. Based on the FGDs, many of the farmers resort to the use of food wastes and composts because they are unable to procure inorganic fertilizers. In as much as this method is good for the environment, the current levels of valorization of organic substances in most of Africa and the four study sites remains low, and it has been argued that organic fertilizers can only increase yields to a certain threshold or level beyond which outputs will remain constant unless they are combined with inorganic fertilizers. A study carried out in Kabate, Central Kenya, examines the effects of soil management in the context of the effects of organic and inorganic inputs on soil biomass and productivity and confirms the argument that the current levels of organic manure usage in most of Africa cannot sustain production [31,32,34,35]. It has been argued that organic resources alone are often unable to provide sufficient nutrients to maintain long-term nutrient resource bases for agriculture [34,35]. Therefore, the best case scenarios of nutrient provision are when both organic and inorganic fertilizers are used at the same time [34,36]. In relation to this, the prospects of organic manure or agro-ecology methods are seen as methods that cannot stand on their own to sustain yields. This of course is linked to the fact that the systems have not been well developed and valorized as is the case in countries like Gambia and Malawi.

This study has found that the main adaptation approaches used by farmers to enhance production in the four study sites are: expansion of farmland, help from relatives and other dependents, supplemental occupations and use of organic fertilizers. So far, as seen in the results above, it can be said that most of the farmers depend more on problem solving mechanisms than on the social-support mechanisms with the exception of help from relatives. The role of policy, government, tribal and religious leaders appears to be weak based on the population perceptions. Therefore, adherence to CSA as a means of enhancing agricultural production is essential. CSA can be regarded as a set of integrative approaches that are context specific and used to combat the challenges of climate change and increase food security. CSA is not a set of practices but a set of approaches that fit specific contexts. CSA involves two main elements; these include: *services to farmers* and *land management options (*on the farm*)* that aim at conserving ecosystem services. From this perspective, the prospects of CSA for science management will be based on these two elements that are discussed in detail below (Figure 1).

In the area of *farm management or on-the-farm options*, a number of sub-categories can be identified. The first component has to do with the *quantification of farm inputs*. This category involves the quantification of farm inputs through the amount of fertilizers that farmers can apply on their farms which may well prevent crops from perishing because of too little or too many fertilizers. The hand-held green seeker (Trimble Navigation limited, Folsom, CA, USA) is a device that can be used to attain this objective. This is a device that calculates the Normalized Difference Vegetation Index (NDVI) which is a proxy for plant health, vigor and fertilizers need levels. The advantage here is that the farmers will be able to know the fertilizer requirements for their crops by placing the device over their crops; this avoids a situation in which farmers just apply fertilizers without knowing the actual plant fertilizer requirements. Governments and extension services can help to borrow or rent out these devices to the farmers. The second on-the-farm option involves *investments in agroforestry and mixed farming*. Trees can increase above ground biomass, provide litter and enhance soil organic content as well as enhance soil organic carbon and nitrogen which are very vital for crop yields [37]. Globally, about 1.2 billion people are using agroforestry methods in their farms [38]. In integrating trees into farms, the farmers have to be careful; the types of trees to be planted should be indigenous fruit trees [39] that have implications on planting decisions which are also impacted by socio-cultural values [40], market, food and the medicinal value of trees [33]. Examples of such trees may include: pawpaw, cocoa, coffee, avocado, mango, cashew and banana, *etc.* These are trees that produce fruits that can be eaten and sold [41]. Mixed cropping on the other hand involves the growing of crops and keeping of animals. A true opportunity for agroecology here is that the trees benefit from the droppings of the animals as manure while the wastes from the crops serve as food to the animals or are used to produce compost, a real opportunity for agroecology and diversification of livelihoods [42]. The last on-the-farm option has to do with *the valorization of agroecology* through the following pathways: (1) natural control of diseases and pests through the use of nets and predator-prey strategies rather than the use of chemicals; (2) accumulation of organic matter and nutrient cycling through the use of natural processes; (3) improvement of biological interactions, biodiversity and synergies; and (4) conservation of resources such as water, soil, biodiversity and energy.

The *services to farmers* involve a network of actors and stakeholders that will finally impact adaptation policies. At the fore of this, we have farmers who have excellent *indigenous knowledge* based on their experience in farming for several years and they have basic indigenous techniques used in combating stagnation. This is exactly what this study has been able to verify via the actual perceptions of the farmers in relation to the actual techniques of adaptation used. In addition, *learning and training* schemes could also go a long way to enhance adaptation. This should provide the farmers with the basic skills needed, for instance, to interpret climate data and understand why their planning dates have to be changed and why the planting species have to be changed. In addition, *financial mechanisms* such as Reduction of Emissions from Deforestation and Forest Degradation (REDD+) should be placed at the disposal of the farmers. Such initiatives would enhance farmers' participation in agroforestry since the financial benefits will become obvious. The challenge here is how to get the funds down to the right farmers in a society where corruption is rife. Another component of this section has to do with the carrying out of *evidenced based research* which should be anchored on scenarios and forecasting, all driven by data on variables such as growing season rainfall, temperatures, and land use change *inter alia*. Such evidence-based research will directly impact adaptation policies as well as the third component which involves climate change variability and sowing information. *Media outlets* could develop slots and programs in which such *information on planting dates and sowing species* are determined. Cell phone companies could also enhance the information sharing process by updating farmers with all this information.

5. Conclusions

This study has revealed that current production yields in four study sites in Cameroon are declining. In addition, the current indigenous adaptation options include: farm size increase, help from relatives, becoming involved in supplemental occupations and the use of organic fertilizers. This study argues further that, due to persistent crop yield declines in the midst of the adaptation options above, many prospects still exist, especially in the area of services to farmers and land management practices (CSA). The options for CSA are suggested here as adequate adaption options that can be used to increase food security, reduce poverty and protect the environment. The current options that are used are not sufficient enough in bringing about positive radical changes. Depending mostly on farmland expansion, family labour, supplemental occupations and organic fertilizers cannot sufficiently change things. It is within this context that CSA is suggested as a way forward as the current cooping options simply maintain the status quo. Adaptation options should be context specific, based on farm level adaptation options and off farm level approaches such as providing pertinent services to farmers. Emphasis and further research is needed in: testing the hypothesis stated in this study at larger scales, verifying the patterns of systems of effective information diffusion, especially in terms of the role of cell phone companies and media outlets in training and making adaptation information available to farmers, the potentials of REDD+, and an evaluation of the potential effects of training programs that have empowered farmers in taking climate smart planting decisions. Furthermore, adaptation science has to be adapted to changes itself. This means that multidisciplinary challenges must be faced with multidisciplinary solutions.

Supplementary Materials: The following are available online at www.mdpi.com/2077-0472/6/2/22/s1: Table S1—Title: Socioeconomic properties of the 200 respondents in all four study sites. Table S2—Title: Assessment of respondent's perceptions of adaptation options.

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