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An Explorative Survey on Challenges Facing Citrus Farmers in Makueni County, Kenya

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ABSTRACT

The paper aimed at investigating the main challenges facing citrus (sweet orange, pixie, and tangerine) farmers in Makueni County. A sample size of 150 citrus farmers was purposively selected across Ngutwa, Nziu, Kilala, Kitikyumu, and Kalamba regions due to their predominance in citrus farming. Primary data was derived from farmers and key informants from the Makueni sub-county. Secondary data was also used where necessary. The study depicts that citrus farming in Kenya and more specifically Makueni County is challenged by pests and diseases, lack or poor agricultural extension services, low pricing due to stiff competition from Tanzania, poor farmer organization, lack of sustainable commercialization, expensive inputs, inaccessibility to credit facilities, erratic patterns of weather, poor marketing, poor road infrastructure and land use, and traditional tenure system. Pests and diseases, erratic weather patterns, and poor marketing network were common challenges in all the areas where data was collected. There was a close relationship and persistence between climate change, pests and diseases as core challenges whose occurrence are dictated by nature. To build resilience and adaptation to these external factors, it is necessary to invest in sustainable, anticipatory measures through the adoption of agricultural technologies that offer increased productivity. The findings of this study form important baseline information that is necessary for guiding further bio ecological investigations. Besides, the results are vital in developing proper policies that aim in developing citrus farming in the country.

Keywords: Citrus, Pest, and disease, Agricultural extension service, Low-pricing, Agricultural technologies, Bioecological investigations

INTRODUCTION:

In Kenya, agriculture plays a key role in economic development by employing more than 40% of Kenyans and more than 70% in the rural population [1]. The horticulture industry (fruits, flowers, and vegetables) is one of the most promising in the Kenyan economy. Its products account for 21% of all agricultural exports [2]. Although the sector has faced 32% decline in terms of acreage since 2013, both value and production have increased by 3% and 7% respectively [3]. The global orange production in 2016 was 66, 974.1 metric tons and Kenya contributed 114.4 metric tons [4]. Oranges are the fifth most consumed fruit after bananas, mangoes, avocado, and pawpaw [3]. In 2018, Kenya produced 199,183 tonnes of citrus up from 184,079 tonnes in 2017, which registered an increase of 8.21% [5].

Citrus is a wider name for several species such as pomelo, lemon, citron, Tangerine, mandarin among others. Citrus remains a vital horticultural crop in Kenya [6,7,8]. They can thrive well under wider area, from low altitudes at sea level to highlands at 2100m above sea level. Sweet oranges, mandarin, and pixie are the main citrus species that are grown commercially.

Orange farming in Kenya does well in the arid and semi-arid lands (ASALs), predominantly in the Ukambani regions (Makueni and Machakos) and some coastal parts such as Voi. Wangithi[9]notes that the area under citrus was relatively higher in Makueni County at 13,482Kg/Ha as compared to 9692Kg /Ha in Machakos County. Orange growers are mainly small-scale and characteristically attain 4 -10 tonnes per acre [8]. Oranges also do well in central regions of Kenya such as Murang'a and Nyeri and some parts of Western Kenya. The main growing areas in Makueni Sub-county are Mumbuni, Wote, and Nzaui locations. In these areas, oranges are grown commercially and contributes hugely to household income. The fruits are sold locally in open markets or transported to Mombasa, Nairobi, and Nakuru, which are the largest target markets.

In Kenya, Makueni County is a high potential area for the production of Citrus fruits, especially sweet oranges, mandarin, and tangerine. These three species of citrus are marketed through domestic chains within the study area. Considering the high potential yield of Citrus in Kenya and the rapid development of the global horticulture trade, there is a need to embark on transformative agricultural initiatives that will optimize on the sustainable and profitable production of the crop. Therefore, the present study aimed at establishing the main challenges faced by citrus (Sweet oranges, tangerine, and mandarin) farmers in Makueni County, Kenya.

MATERIAL AND METHOD

Study Area

Makueni county has a total landmass of 8,008.9 km² with an estimated total population of 987, 653 [10]. The county is geographically located between Longitude 37°10′ and 38° 30′ E and Latitude 1° 35′ and 3° 00′ S. Makueni county is found in the arid areas of former Eastern Province. It borders Taveta to the South, Machakos to the North, Kajiado to the west, and Kitui to the east. The county registers a rapidly growing population, reduction in food production, water scarcity, and a partial resilience to climate variability and change (Makueni County's Integrated Development Plan (CIDP), 2013-2017). The climate of Makueni county is subject to great seasonal shifts and the magnitude of the Intertropical Convergence Zone (ITCZ). The average yearly precipitation is 600mm and bimodally distributed [11].

The present study was conducted among small-holder farmers in Makueni sub county (Kenya) in the villages of Ngutwa, Kitikyumu, Nziu, Kilala, and Kalamba. These areas were purposively selected for the study due to their predominance in orange farming. Within this study area, long rains fall between March and June while the short rains are experienced at year-end, between October and December. According to Gichuki [12], 60% of the annual precipitation fall as short rains and 37% in the long rains. Thornton *et al*[13], notes that a relatively good season for the farmers in Eastern Kenya is marked by an early onset of rainfall.

Data Collection

Exploratory survey was used for the study. The design was appropriate because the study aimed at gaining insights from farmers to better understand the problems they face. It used a sample size of 200 respondents drawn from different locations and of varying age bracket. However, due to constraints in budget and non-response rate, only 150 farmers were interviewed. Such a sample size was sufficient to use according to Sekaran and Bougie [14] who argued that a sample size should not be less than 30% of the population. From the five regions; Ngutwa, Kitikyumu, Nziu, Kilala, and Kalamba, 30 farmers were selected from each area. A purposive sampling procedure was employed to determine the farmers who were to be interviewed in each of the five areas, based on the acreage under citrus. Data was collected using interviews and questionnaires. Questionnaires were primarily used to capture primary data. Field surveys, personal observations and interviewing key informants such as local citrus traders, and sub-county agricultural officers were also used. Key informants were also purposively selected because of the skills, experience, knowledge, and crucial information they have concerning citrus production in the selected areas.

RESULTS AND DISCUSSION

(a) Demographic Characteristic of Respondents

According to gender distribution, 80.7% of the respondents were males, 19.3% were females and 68% of those interviewed aged between 26-55 years. Most of the respondents (58.7%) had acquired education to secondary level with 3.3% having no schooling at all (see table 1)

Table 1: Demographic Characteristics of Respondents

Characteristics	Categories	Frequency	Percentage (%)
Age Distribution	18 -25	7	4.7
	26 -55	102	68
	56 and above	41	27.3

Gender Distribution	Male	121	80.7
	Female	29	19.3
Education Distribution	No schooling	5	3.3
	Primary level	57	38
	Secondary	88	58.7

From the table above, most respondents' age ranged between 26 and 55 years which is the working-age group according to Kenya's demographic composition. The distribution also points to the duties and responsibilities in the community in terms of citrus production and marketing. Regnard [15] argues that the age of a person significantly contributes to wealth accumulation. Besides the level of maturity, one's age affects the ability to make informed decisions. Likewise, age determines individual's maturity and ability to make rational decisions. According to Mlambiti [16], age structure can be used to explain the labor potential in a population.

From the table 1above 58.7% of the farmers had acquired secondary education meaning that citrus farmers had basic knowledge and skills on the agronomic production of citrus fruits. Education has a direct influence on good husbandry practices. In the study to determine the citrus yield losses due to pests and disease in Makueni County, Wangithi [9] notes that the respondents had at least an average of 9.78 years of schooling. The present study affirms that most of the farmers has at least acquired the basic education that is important in citrus farming. The level of education equips the farmer with the ability to get information with ease, flexibility to try emerging technologies, and the general ability to make on-farm decisions. According to Annah *et al.*,[17], studying agriculture as a subject in secondary school was found to increase agricultural productivity.

It is oblivious from the study that both men and women were involved in citrus farming. However, the disparity in gender distribution with majority being males (80.7%), purely echoes the concept of African family roles orientation. According to most African societies, gender roles and responsibilities were rigidly structured. As such, women were seen as mothers and caretakers while their male counterparts assumed the roles of productive activities. Previous studies support these results where more men than women are in citrus farming. According to Aragon & Miller [18], gender inequality and deliberate structural disempowerment of women make them poor and alienate them from economic empowerment. Similarly, accessibility to capital may contribute to this discrepancy. As noted elsewhere by Kabeer [19], in developing countries, more women than men have limited access to means and factors of production. Therefore, gendered roles, inequality, and disempowerment make women lesser actors in economic development not only in the study area, but the world over.

(b) **Variations in Conditions of Weather (Precipitation and temperature)**

Makueni subcounty lies within an arid and semi-arid region and therefore, shortage of rainfall and high temperatures was found to be a great challenge among the citrus farmers. Most of the farmers in the study area heavily rely on rain-fed agriculture, therefore, increased aridity due to climate change, coupled with their low income narrows the list of options to build up resilience. Inadequate rainfall causes poor flowering which in turn bear small and unattractive fruits. To reduce excessive water loss, these fruit trees shed their leaves during dry seasons. Besides, rising temperature has been found to cause flower and fruit abscission. Chang and Petersen [20]notes that water is essential for citrus fruits during their flowering, fruit development, and after harvest. Therefore, a shortage of rainfall and high temperatures are believed to cause massive stress to citrus fruits within the study area. The area, just as other Sub-Saharan African countries, is particularly prone to the effects of climate change due to overreliance on unsustainable production and poor adaptive or mitigating capacity [21]. Other attestations of climatic fluctuations within the Makueni subcounty include the number of rainy days. Sometimes, the rains in the said locality start late and end early leaving the fruits to inadequate water for their development. These changes have served to spur uncertainty in both decision-making and planning at the farm level.

(c) **Citrus Pests and Diseases**

The dynamics of citrus diseases and pest increase are fast changing because of changing climate. Consequently, controlling them has become an up-hill task for many low-income citrus farmers. Several studies have stressed pests and diseases as the main challenge facing citrus farming [6,22,23,24,25,9]. Areas falling within the tropics have more exposure to sunlight and thus ideal for the citrus farming. Unfortunately, these conditions favor the growth and development of pests and diseases. Variations in temperature, water, and carbon (IV) oxide concentrations can neutralize, speed up, or slow down the development of diseases[26]. Increased carbon (IV) oxide due to enhanced human activities increases simple sugars within leaves and decreases the concentration of nitrogen in them. Therefore, pests will eat more leaves to sustain their nitrogen metabolic requirements and thus causing more damage.

Some of diseases reported by the respondents include Citrus wither tip caused by *Colletotrichum gloeosporioides*, citrus canker (*Xanthomonas citri*), Citrus gummosis (*Phytophthora* spp.), Citrus greening, Citrus anthracnose. The greening disease which was reported as the most destructive by the farmers is transmitted by the African Citrus Psyllid and attacks citrus irrespective of their rootstock. The disease may be confused with nutrient deficiency as the infected leaves portraysa chlorotic pattern, corking of the veins and yellowing. This was evident from field surveys as some farmers cited the condition as lack of adequate manure to their citrus plants. While the vein corking can be confused with insufficient boron to the system, chlorotic islands can be confused with zinc deficiency. Similarly, Citrus leaf miner, Aphids, Citrus whiteflies, Oriental Fruit fly and Citrus thrips also proved to be a more prevalent pest to the citrus farmers.

	Disease	**Identification Images**		**Preventive measure (s)**
1	Citrus canker			•Remove fallen leaves, fruits and branches from the ground and destroy them. •Destroy severely infected trees to prevent infecting healthy trees nearby. •Monitor the trees for signs of the disease. **Treatment:**Copper based fungicide or bactericides.
2	Citrus greening			•Monitor the citrus groove regularly for symptoms of the disease. •Remove affected trees immediately. •Maintain proper hygiene among workers and tools. •Remove alternative hosts of the psyllids.
3	Citrus gummosis			•Avoid wounding especially near the trunk base. •Avoid contact between furrow irrigation water and the trunk of the trees. •Remove dead or infected tree material immediately. **Treatment:** Bordeaux arietta or ridomil spray, copper fungicides at early stages of disease, foliar application (fungicides containing fosetyl-aluminium) and a soil drench of metalaxyl is an effective complement to preventive and biological control of the fungus.
4	Citrus Anthracnose			•Plant resistant varieties/healthy seedlings. •Plant non-host trees such as coffee around. •Prune trees yearly to enhance ventilation. •Remove fallen fruits and leaves around. •Keep the field clear of weeds. **Treatment:**Fungicides containing azoxystrobin or chlorothalonil,Bio fungicides based on *Bacillus subtilis.*
5	Citrus wither tip			• **Treatment:** Use of copper fungicides.
	Pest	**Identification Images**		**Treatment**
1	Citrus leaf miner			• Parasitic wasps attack/feed on citrus miner's larvae. • Use formulations containing abamectin, tebufenozide, acetamiprid, diflubenzuron or spinetoram. • Organic insecticides containing spinosad, fish oil resin soap and pongamia oil can be used as foliar spray

2	Aphids			• Pesticides with active ingredient of fipronil, thiamethoxam, acetamiprid or flonicamid can be used.
3	Citrus thrips			• Formulations containing abamectin, dimethoate, and cyfluthrin.
4	Fruit flies			• Usage of traps • Biological control

Figure1: Pictorial presentation of main citrus pest and diseases within the study area.

(d) High Cost of Production (Inputs)

Bringing a citrus plant into production is an expensive task that calls for high resource investments and patience. The prevalence of pest and diseases within the study locality is partly because of the prohibitory cost of production. The farmers complained of the high cost of buying farm inputs which greatly reduce their profit margin. For example, rootstocks are expensive and take time to attain the grafting stage. During the development of the rootstocks (lemon seedlings), they require a lot of labor in weeding, watering, and care from ants, especially during the dry season. After grafting, the plant also needs frequent watering for the scion to develop and grow. The cost of pesticides and herbicides is also high, a factor that causes huge losses due to pest and diseases. Failure to eliminate weeds either physically or through application of herbicides leads to more habitats for pests. Besides, many farmers could not afford irrigation equipment and postharvest storage facilities which leads to losses.

Figure 2: Herbicide (KAUSHA 480SL) applied on weeds in a citrus field.

Citrus farming is a labor-intensive venture requiring good husbandry practices to bring it into a profitable bearing. The most common husbandry practices in citrus are weeding and pruning. Lack of investment capital and incentives has made it hard for citrus farmers to carry out proper weed and pest management. Most citrus trees are highly infested by weeds and other herbaceous climbing plants. Common weeds in citrus plantations are Blackjack/ 'Munzee' (*Bidens pilosa*), Couch grass/'Kithangai' (*Digitaria scalarum*), *Bristly starbur*/'Ikongo' (*Acanthospermum huspidum*), Star grass/'Ikoka' (*Cynodon dactylon*), Oxalis/ 'Mwelia' (*Oxalis stricta*), Camel bush/'Mukutu' (*Trichodesma zeylanicum*) and purple nutsedge/'Mbiu' (*Cyperus rotundus*). Couch grass and purple nutsedge possess underground rhizome systems, which makes them highly invasive and difficult to control [27]. Therefore, farmers opt to use more effective herbicides, less labor cost, and less time consuming as compared to tillage.

Figure 3: (a) Proper weed management on citrus orchard(b) Citrus plant heavy with pixie oranges (c) A basin dug to traproad run-off water

(e) Infestation by Parasitic *Cuscutaspp*.

Citrus farmers in Makueni County are struggling with an emerging challenge of giant dodder plant that attach itself to their citrus plants. The invasive and parasitic plant damages citrus to the extent of making the plants dry up. Wind, birds, water, and other animals spread this killer weed. As some of the farmers observed, the killer weed first attacked wild trees but currently it is causing havoc on ornamentals with in homesteads and even their crops. Some farmers even cited that the parasitic plant was spread by children who cut pieces of it and throw it elsewhere on other plants just for fun.

Studies show that this weed has a high virulence in the transmission of citrus greening disease [28]. The golden dodder is an obligate stem holoparasite that winds around and penetrates the host plants through haustoria that reach the vascular bundle system to draw nutrients and water [29]. Saric-Krsmanovic and others [30] observed that the parasitic plant causes a decline in the chlorophyll content in the host plants. The warm climate of the study locality favors the establishment, growth, and the spread of the weed. With no efficient herbicide in the control of the golden dodder, citrus farmers will continue facing a challenge in the management of this parasitic plant.

Figure 4: Giant Dodder (*Cuscutareflexa*) on sweet orange plant in Makueni County.

Figure 5: Giant dodder on avocado plant.

(d) Competition from Other Producers

The farmers cited competition from other citrus producing area such as Tanzania as another challenge they face when selling their produce. An influx of citrus from Tanzania is one of the main factors that greatly affect the market value of citrus from Makueni county. Although Tanga and Morogoro produce the seeded oranges, their entry into Kenya causes a glut in the market. As such, the Tanzanian citrus creates unfair competition in the market as they are normally subsidized or produced at a lower cost as compared to Kenya's. Therefore, the Tanzanian citrus tends to be cheaper [31]. Most farmers complained about low prices offered by buyers especially during the peak seasons from June to September. To widen their profit margins, these citrus traders first go for the cheaper Tanzanian citrus, a factor that retards price increase during Kenya's citrus harvesting periods.

(h) Poor or Lack of Agriculture Extension Services

While skewed weather patterns contribute majorly to food insecurity globally, lack or insufficient good agronomic practices equally have a share of the blame. Kenya's agriculture system is deficient in agricultural extension services while private extension services are too expensive for the smallholder farmers. The ineffective and poor agricultural extension has caused poor agricultural productivity [32 & 33]. Most farmers recount to have received some agriculture extension officers from the government in the 1980s but not in the present times. The few who visit their farms are normally profit-motivated from agrochemical companies to market their products. The lack of highly trained and qualified extension officers to offer extension outreach on citrus farming is a missing link for the farmers. Most of them do not know the best insecticide to use and when, pruning mechanisms and procedures, knowledge on alternating the Active Ingredients (AI) of chemicals, scouting, and identifying pests, grafting, and best scion varieties.

(i) Poor Commercialization of the Crop

As compared to other crops such as potatoes, tomatoes, tea, mangoes, and coffee, the citrus industry in Kenya lacks formal commercialization. There is no formal and standard system of marketing, a factor that has posed challenges to the development of the crop. Sustainable commercialization of crops brings about profitable production of a particular crop [34]. The idea behind sustainable commercialization is based on the coordination and governance of innovation through marketing, integration in the present agroecological systems, and germplasm development of the crop [35]. In Kenya, there is minimal formal development of planting materials of the crop. Although Oxfarm produces and sells citrus seedlings, most of them are cultured by individual small-holder farmers. Besides, citrus farming has not attracted research as compared to crops like mangoes or cereal crops like maize.

(j) Poor Market Linkages and Cartel Networks

Most citrus traders are brokers who buy farmers' produce at a throw-away price and sell at lucrative prices. Besides, farmers who are lucky enough to have a means of transporting their products cannot enter the main citrus markets in Mombasa, Nairobi, and Nakuru. The citrus market is highly fragmented into a cartel system and brokers that determine both on-farm and market prices for the produce. The brokers and cartels block new entrants into the physical markets and command huge profits while the farmers get a pittance. Citrus farmers remark that the citrus market system has become a system for exploiting them. One farmer narrates a story of how he loaded a lorry of his produce for sale at Kenya's main fruit market, Marikiti. To his disbelief, his on-demand Makueni citrus could not enter the market and in fear of his fruit going bad, he was forced to sell them at a dictated low price. The normal consensus is that after the middlemen identifies a farm and agrees the price per unit kilogram with the owner, the broker brings in hired casual laborers for picking. After picking, the owner of the farm together with the broker weighs the fruits and then pays the farmer, after which transport arrangements made.

(k) Poor Road Infrastructure Linking the Farms

The essence of good and reliable transport connectivity to rural areas in agriculturally potential areas cannot be overemphasized. Good infrastructure enhances the smooth flow of information between farmers and buyers. Farmers are connected to marketing opportunities, input supplies, and other agriculture-related services [36]. Kydd and Dorward [37]find out that remote areas in developing countries often have poor roads and telecommunications networks; a deficiency of a developed and diverse monetary economy; a poor flow of market information and high levels of opportunism among contractual actors of agricultural producers. Farmers face a challenge during harvest periods in terms of transporting their produce from their farms to main roads. Most of the citrus farming in Makueni County is done in remote regions that are linked with poor road connectivity. Some roads are unpassable during the rainy season. Farmers in these regions are forced to find alternative means of transport such as the use of animal labor to get their produce to the main road. Besides, the buyers are reluctant to buy produce in areas that will pose them a challenge in getting the fruits to the market at the right time.

(l) Traditional Land use and Tenure System

The conventional tenure system on the use of land has led to massive division and subdivision of land, leading to declining production. Human settlement and the division of land for inheritance are posing a great challenge to citrus production in Makueni County. The newly introduced family setting must set part of that land for a homestead. Therefore, citrus farming faces a decline in production per unit area, and farming in such small lands is not economically viable. The increased land sub-division forces farmers to carry out multi-cropping where common crops such as maize, beans, cowpeas, and pigeons are planted amidst the citrus plants. To the farmers, their small-scale and low-input production system generates more returns before the citrus attain maturation. Besides, the degree of weed infestation is reduced. In such a system where ox-drawn plows are used, the citrus faces injury especially the branches and roots. Since citrus develops an extensive root system, the farm machinery induces massive root damage which increases the susceptibility to soil-borne diseases. Whenever the animals move around the plants, they normally break the branches, cause flowers or fruit to drop. Damage to the branches increases the susceptibility to citrus gummosis. In a study to investigate the productivity of sweet orange when intercropped with other crops in Nigeria, there was a significant decrease in canopy diameter of sweet orange and delayed early fruit set where maize, soybeans, and cassava were grown amidst the citrus plants [38]. Amih[39] noted that intercropping significantly reduces the productivity of citrus.

Figure 6: Maize grown on a citrus orchard.

(m) Poor Organization among Citrus Farmers

Most farmers work as individuals and no subscription to a farmer's group. One farmer's group that gained local popularity within the study area was Nzaui cooperative society among cotton farmers in Nzaui location in the 1980s. Sometimes without such an organization, it is very hard to set a collective starting price per kilogram of citrus, which further widens the door to intermediary's exploitation. Most farmers interviewed claimed they do not understand the advantages of belonging to a farmer's organization. Farmers, therefore, lack the knowledge and positive attitude on how such organizations can help them produce and market their produce. Therefore, farmer education is needed before enrolling farmers in such organizations. Working as an individual makes the citrus farmers operate on high transaction costs. Functional organizations are formed among farmers who subscribe to common interests and therefore use the organization as a stepping stone in tackling obstacles in both production and marketing. Belonging to a group empowers farmers to

possess economies of scale. Also, farmers are also able to influence marketing networks and attract better prices. The inability to work as a group leads to poor information sharing, transport sharing inconveniences, and marketing.

(n) Lack of credit/Investment Capital

Citrus farmers in Makueni County have little or no access to low-interest borrowing to purchase equipment and other inputs. The smallholder farmers, most of whom do not subscribe to a farmers' cooperative, therefore face financial constraints in citrus production, from paying of labor to agrochemicals, farm equipment, and other on-farm costs.

CONCLUSION AND POLICY IMPLICATIONS

Conclusion: Citrus is a very important fruit in Kenya's horticulture. Citrus production in Makueni County contributes significantly to the rural economy, reducing poverty rates through creation of rural employment. The Makueni region enjoys conducive soil and climate for the production of citrus fruits. However, pests and disease, unreliable rainfall, low farm-gate prices, lack of proper farmer-organization, expensive inputs, lack of government support and subsidies, poor road infrastructure, uneconomical production due to land sub-division, and lack of commercialization of the crop are the main challenges to this potential. Addressing key challenges to citrus farming would be a great move to optimize profitable production. Proper commercialization of the crop would redirect more returns to the farmer. Agricultural extension services are a major turning point in addressing agronomic practices and the management of citrus. The need for more research in the citrus industry is necessary to address key diseases and pests that cause huge economic losses. Improved governance, building both organizational and human capacity, and proper agricultural policy formulation is key to address these challenges. Development of new varieties, dissemination of new technology, assured input supply, access to financial services, and strong marketing support are actions that can be taken towards solving these issues.

Policy Implications: Agriculture is the main source of livelihood for most rural people in Makueni and most households in Kenya. Therefore, adaptation is key to build long-term resilience and sustainability of the sector, sustain lives and promote food security. Therefore, the government (both national and devolved) and other non-governmental actors have a key role in addressing challenges facing citrus production. Development of suitable citrus crop varieties, reliable input supply, capacity building, strong marketing efficiency, access to credit, and provision of extension services to the farmers are some of the key areas to address. The effects of climate change are a major impediment to agriculture globally and therefore short-term coping strategies are not enough in addressing the threats accrued. Therefore, the rural farmers need more support in their citrus farming. Design and installation of irrigation infrastructure would play a key role in the adaptation and resilience of the local farmers. Agricultural extension services should also transform to integrate climate research and information services. The transformation will create simple communication approaches that will simplify climate information to farmers for informed preparedness to impending climatic risks.

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