



AGRICULTURE AND SUSTAINABLE DEVELOPMENT: A CASE STUDY OF LIBYA

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ABSTRACT: *The current study investigates issues related to sustainable agriculture in Libya in the light of various theories of sustainable agriculture. The rationale for this study is the need to investigate the importance of a sustainable agriculture sector as the country diversifies its sources of revenue. The aim of the government is to reinvigorate the country's once-thriving agricultural sector in the interests of food security by minimising its need for food importation. Semi-structured interviews were conducted with farm workers and managers to elicit their views on the current state of agriculture in Libya, the challenges they faced due to arid climatic conditions and their opinions as to what needed to be prioritised in government agrarian policies. The key findings which emerged from thematic analysis are then presented and discussed. The study concludes with recommendations which the participants considered important for combatting the challenges to sustainable agriculture in desert regions.*

KEYWORDS: Sustainable Agriculture, Irrigation, Food Security, Labor Shortages, Climate



INTRODUCTION

The aim of this study is to analyse and evaluate the sustainability of Libyan agriculture. Sustainability, in this context, has been defined as agriculture which integrates the principles of environmental soundness, economic viability, but also that of social equity (Allen, Van Dusen, Lundy, & Gliessman, 1991). Although agriculture is seen as impacting on natural resources as well as the environment (Calabi-Floody and et.al., 2018), earlier authors such as Allen, Van Dusen, et al. (1991) had already insisted that societal aspects also needed to be considered. Sustainable agriculture, therefore, involves the integration of a broad range of economically viable production practices which protect the natural environment as well as ensuring that the needs of society for food and other products are met.

Although agriculture is the second largest sector in the economy, Libya depends on imports for 75 per cent of its food requirements (OECD, 2011) due to the extremely dry climate which is characteristic of its large expanses of deserts (Holloway & Mengersen, 2018). Natural resources of fresh water are limited and insufficient for a thriving agriculture sector capable of meeting the food demands of its growing population. Currently, the country is politically unstable. However, since the 1980s, there have been attempts to revive traditional agriculture, aiming at self-sufficiency, by developing irrigation schemes such as the Man-Made River Project (Zidan, 2007) and investment in modern agricultural machinery. However, these attempts only achieved limited success mainly due to mismanagement. Focusing on the social equity dimension of sustainability, Libyan citizens are faced with food insecurity and high prices for imported food. In the previous decade, the annual cost of imported food in Libya was US\$ 3.9 billion and was reported to be growing at an annual rate of 20 per cent (Arab Organisation of Agriculture and Development (AOAD), 2010). Consequently, the government in Libya is currently aiming at improving domestic food supplies through agricultural development (Cristache, Vuță, Marin, Cioacă, Vuță, 2018). Accordingly, this study assesses the sustainability of current agricultural practices in order to recommend measures for its improvement.

LITERATURE REVIEW

Climatic and economic conditions in Libya

Many farmers in both developed and developing countries rely significantly on their own agricultural production to meet their families' food requirements. Thus, it is a primary source of their sustenance as well as providing them with direct employment as their source of income (Jancker, Mann & Rist, 2018). However, due to its arid climatic conditions and scarce water supply, agricultural output is low. The Man-Made River Project and desalinization plants (Zidan, 2007) provide significant volumes of fresh water for irrigation purposes of soil which would otherwise be arid and infertile. These irrigation sources have made possible the growth of olives and dates which do not require large volumes of water. Additionally, barley and wheat are grown. Despite the extent of its dependency on imported farm produce, agriculture is important for the sustainability of the Libyan economy in the future as dependency on fossil fuel revenues declines.



Currently, Libyan farmers produce crops on a small scale. This means that most of the food that is produced is consumed by people living in the country but it is still not enough. Thus, the country imports huge amounts of agricultural products from different countries. However, the importance of agriculture is not confined to producing food but also to providing raw materials for ancillary agri-industries (Jhariya, Banerjee, Meena, & Yadav, D. (Eds.), 2019). Thus, agricultural development is important for the sustainability of the national economy, especially as fossil fuel revenues begin to decline. Thus, agriculture will become increasingly important for the national economy and this implies that the government needs to focus on those agricultural products, such as olive oil and date production, which offer the country the potential to gain a competitive edge over its rivals. There are three major types of challenges to increasing the scale of production which are labor shortages, fresh water supplies, and soil erosion. Each of these challenges are discussed later in this study.

The Libyan government is focussed on implementing sustainable agriculture in the country. The soil quality Libya is of poor quality and this limits the range of crops which can profitably be produced by desert farming. A large area of Libya is spanned by the Sahara Desert. Consequently, the country will always have to import certain agricultural products such as rice. Nevertheless, there are crops such as olives and dates which do not require large volumes of water. If the country increases production of those crops which are amenable to desert cultivation, it can meet domestic demand as well as exporting significant quantities of these products to contribute to the national economy. Thus, the threefold dimensions of sustainability, namely environmental soundness, economic viability, and social equity can be achieved. Nevertheless, the challenges facing desert farming are significant. These include the provision of fresh water where rainfall is extremely low, the maintenance of soil suitable for cultivation, and the availability of labor for agricultural projects (Kociszewski, 2018).

Before discussing the challenges facing the Libyan Government in respect of agricultural development, a number of theories of sustainable agriculture are assessed with a focus on the climatic and economic conditions of the country.

Theories of sustainable agriculture

Three types of theories are discussed here namely, ecological, regeneration and agroecosystem type theories.

Ecological theories

These theories conceive of agricultural development as activities conducted in such a way as to meet current needs without harming resources for the future (Akpabio and Umoh, 2021). This entails the adoption of eco-friendly practices. These practices are not limited to irrigation but also include an understanding of the role of microorganisms in maintaining the fertility of the soil (Shahrajabian, Chaski, Polyzos, & Petropoulos, 2021).

Authors such as Ngondjeb and Ayuk (2021) have shown how agriculture has dramatically changed in recent years in ways that have improved food and fibre productivity. This has been due to the application of new technologies as well as increased mechanization. Additionally, the use of chemical fertilisers, crop specialization and other measures embedded in government policies have helped to increase the quality of crops and yield quantities which have resulted in reductions in food prices. Nevertheless, these developments have also had negative effects. For example, the excessive use of chemicals can lead to the depletion of topsoil quality. Other



ecological issues include groundwater contamination, greenhouse gas emission and air pollution (Li, Wang, & Li, 2020). These undesirable side effects of the modernisation of agriculture need to be mitigated before an eco-friendly form of agriculture is achieved which integrates the three main goals of sustainability which are environmental soundness, economic viability and social equity. The concept and theory of agricultural sustainability is associated with the aim of meeting current needs without sacrificing and compromising the needs of future generations.

Thus, the ecological type theories are based on the stewardship of human resources.

Regeneration type theories

These types of theories are intertwined with meeting social responsibilities within farming practises by the way of ensuring better living conditions of laborers and meeting the needs of rural communities to ensure consumer health and safety in the present as well as in the future (Lim, Jørgensen & Wyborn, 2018). On the other hand, another vital aspect of sustainable agriculture comprises natural resources which aim at maintaining and enhancing the quality of resources along with ensuring that these natural resources would also be allowed to be regenerated in future to meet the future needs and ensuring both social and environmental welfare.

Agroecosystem type theories

Another type of agricultural sustainability theory is provided by Swain and Ranganathan (2021) which revolves around the concept of agroecosystems which is related to food production systems and is considered to be an important perspective for understanding sustainability. A survey of the application of these theory types reveals that they are applicable at individual farm level as well as at the level of complete ecozones. Thus, agroecosystem type theories are associated with food production systems along with its distribution and consumption components starting from the individual farm to the local community as well as including the global population. Thus, these theory types aim at providing a comprehensive view of sustainable agricultural production along with meeting the need for the conservation of the natural environment (Nhemachena, Matchaya, Nhemachena, Karuaihe, Muchara, & Nhlengethwa, 2018).

Furthermore, according to Loiskandl and Nolz (2021), agroecosystem type theories also provide effective approaches to assessing and analyzing the impact of human society on the farming institution and its environmental sustainability along with adopting practises which do not create damage to the land and other natural resources. Thus, the concept and agroecosystem type theory of sustainable agriculture is based on the factors of resilience, adaptability along with adopting diversity. It can be argued that the concept of resilience is an essential dimension of agroecosystems theory of sustainable agriculture, as farming faces many conditions such as climate, political context, pest population and other factors which are highly unpredictable. Thus, resilience is essential for overcoming and meeting all such conditions in order to ensure that agriculture is sustainable. Further, the concept of adaptability is also a key component as it provides possible and desirable agroecosystems to maintain the precise form of sustainable agriculture along with ensuring effective adaptability to face changing conditions related to the farming and food distribution system in a sustainable way (Nikitin, Trunova & Voropaeva, 2019). Finally, another vital component of the theory of agroecosystems consists of diversity



in farming practises which supports the feature of adaptability, as the greater the variety of practises and skills that are available within food systems, the more effective will be the support for the sustainability of agriculture with the help of appropriate tools for effectively adapting to and implementing change.

Drawing on the insights of these theories, in the following section, challenges facing the Libyan Government in implementing sustainable agriculture are discussed.

Challenges to implementing sustainable agriculture in Libya

One of the most formidable challenges to implementing sustainable agriculture in Libya is that of sufficient fresh water supplies for the irrigation of land in desert regions for agricultural purposes (Ladha, Jat, Stirling, Chakraborty, Pradhan, Krupnik, et al., 2020). To meet this challenge, the government embarked on the Great Man-made River project in 1982 (Zidan, 2007) to transport fresh water to northern and desert regions from the water sources in the south of the country through a network of underground pipelines. This project became operational in 1992 and supplied water for domestic purposes to northern cities as well as for irrigation. Additionally, private companies entered into partnerships with the Water Utilization Authority in order to develop sustainable farming infrastructures. Some of these private companies also funded the supply of seeds, fertilizers and technology to enhance Libyan agriculture.

By improving the supply of fresh water, the government aimed to increase crop yields so that more food would be available for domestic consumption. Thus, the government's aim is to modernise agriculture and to augment existing agri-industries (Leal Filho, Azeiteiro, Alves, Pace, Mifsud, Brandli, L., et al., 2018). This has resulted in considerable improvements to overall output as well as reducing the level of imported food. Thus, the implementation of irrigation schemes and the application of modern agricultural techniques has extended the area of fertile land for agricultural production.

Carrying out farming and agricultural activities in Libya is mainly dependent on water supply as well as irrigation. But there are many challenges that the government has to deal with because of operating in an arid region. The main challenges that are faced by the Libyan Government include the effects of a short rainy season, negative water balance, low organic content in the soil and lack of effective clay minerals. There is strong sunlight that is not suitable for growing crops and the temperatures are also high. This means that the rate of evaporation is high and if, during the process of irrigation, water supply is not managed properly, this can lead to an increase in the overall problem. It has been estimated that desertification will become a major issue in the future, due to which the different challenges for the country will also increase. Also, with irrigation being one of the major farming activities in the country, the salinity of the topsoil is tending to increase. Additionally, the lack of water is another factor that increases the overall problem to a great extent. This is because the annual precipitation in the country is also very low. Therefore, it can be said that there are many challenges that Libya has been facing because of its geographical location in an arid region. Moreover, instability in the government of the country has affected the overall crop productivity to a great extent (Calabi-Floody, Medina, Rumpel, Condron, Hernandez, Dumont, & de La Luz Mora, 2018). Another factor is the overall cost of the agricultural equipment and machinery which has been increasing. Due to this, there has been great number of challenges that the country has been facing.



Conventional industrial farming makes use of large amounts of water to irrigate giant tracts of land under cultivation without emphasizing the need for conservation of this valuable resource. In contrast with those traditional strategies, sustainable agricultural practices use several strategies to conserve water, together with drip irrigation and mulching. In addition, it makes a speciality of planting perennial plants with deep roots that do not require large volumes of water. Moreover, sustainable farming embraces strategies that guard water bodies from pollution. Specifically, this farming device makes use of practices inclusive of contour farming and filters out strips close to rivers to restrict the level of infection of the water mass. Agriculture often places significant stress on herbal sources and the environment. However, sustainable agricultural practices are designed to protect the natural environment and to preserve and improve soil fertility. Sustainable farms are capable of producing crops and livestock without the need for using copious quantities of artificial chemical compounds (Varela, Monteiro, Vidigal, Silva, & Romeiras, 2020). Such farms may even avoid practices that degrade the earth's topsoil or that require large volumes of water or other natural sources. Sustainable agriculture integrates the three principles of environmental soundness, economic viability and social equity. These principles are rooted in sustainability philosophies, policies and practices adopted by farmers and their customers. Therefore, it can be said that sustainable agriculture is very important for Libya and will ultimately be beneficial for the overall economy of the country.

In the more arid regions of Libya, cropping is difficult and, consequently, the government has opted for encouraging desert farming in these regions. One related challenge is the rate of evaporation which is higher in these regions as compared with those that receive rainfall. Besides desert farming, there are also certain dry land farming techniques that are used. These techniques have enabled Libyan farmers to produce certain crops more effectively and profitably (Li, Wang & Chen, 2019). Thus, significant levels of government investments have increased agricultural productivity (Heemskerk & Koopmanschap, 2012) and reduced its dependency on the importation of food as well as increasing the exportation of certain agricultural products (Agribusiness development in Libya, 2012).

Accordingly, food security has become a national priority. The strategy regarding the agriculture in Libya is threefold -

1. To increase the potential of production of natural resources in their sustainability level as well as within objectives of economic feasibility (Pan, Zhuang, Zhou, & Yang, 2021).
2. To transfer some crops like forage and wheat crops, to the water abundant Nations by bilateral arrangements of long-term investment.
3. To employ the comparative advantage of country in exporting certain crops as well as value added commodities in order to maximize foreign earnings which may be utilised to purchase food for local demand.

Another challenge facing the Libyan Government concerns the sustainability of food security at household and national levels. This involves balancing agricultural resources in order to increase strategic commodities production like meat, wheat and dairy products, to attain a high food security level and, at the same time, to maintain the sustainable utilisation of resources. An additional challenge relates to the management of foreign trade in order to increase the benefits where the country enjoys comparative advantages as well as tackling the problem of



food deficits. Thus, recent government investments in agriculture have aimed at increasing GDP and establishing greater food security. In addition to this, the government of Libya emphasizes the development of complementary relationships in economic activities which in turn ensures sustainable agricultural growth and improves the agricultural structure in Libya (Sachs, Schmidt-Traub, Mazzucato, Messner, Nakicenovic, & Rockström, 2019).

The Libyan Government also faces various challenges related to the supply of labor in the agriculture sector. Due to the absence of skilled and unskilled labor in rural regions, a consequence of low levels of pay by comparison with remuneration for work in urban areas, a significant percentage of women are involved in the agriculture in Libya. They are usually involved in planting and harvesting operations as well as rearing animals, especially goats, sheep and roosters. It is important to note that women generally work on a circuit of relatives' farms to ensure their safety during outbreaks of violence. Additionally, neighborhood cultural norms tend to discourage or even prohibit women from working for other privately owned farms. Nevertheless, the overall level of involvement of women in agriculture has increased in recent years and they are mainly involved in activities such as the preparation of land for planting and harvesting operations as well as animal husbandry. Women who are involved in agriculture, mainly work on family farms and this is due to poor levels of security (*Libya Agricultural & Livelihood Needs Assessment Report: A Study of Fezzan Region | March 2020, 2021*). Although the economy of Libya is not dependent on agriculture, the Libyan population has begun to experience threats to food security. Consequently, the Food and Agriculture Organization of the country has taken various initiatives in order to address these threats.

Due to political instability and outbreaks of violence, many Libyan workers have emigrated. Additionally, many rural workers have migrated to the cities in search of better paid employment. As a result, agricultural production declined and the country had to increasingly rely on imported food. Those who remained have often experienced food shortages and high prices for imported food forcing them to prioritize food and to neglect healthcare. This is a consequence of a decline in agriculture due to labor shortages.

Apart from devising strategies to attract more workers to be employed in agriculture, a possible solution to the problem of labor shortage is to modernise farming so that it is less labor intensive. Sustainable agriculture requires the application of technology and, beyond that, the development of smart farming innovations (Willer & Lernoud, 2019). However, sustainability also necessitates the elimination of the use of fossil fuels and decreasing power use; in that way, sustainable farming can facilitate the lowering of greenhouse fuel emissions and help to combat climate change.

In the reclamation of land, when new hectares of soil are brought under cultivation, there is an increase in the risk of erosion of topsoil that is rich in nutrients. This can harm the fertility of land and also, contaminate the overall supply of water. Overproduction and use of fertilizers and products for plants as well as crop protection can also affect the overall ecosystem of the country. Many of the issues in Libya are moot points as the available forest land is quite small. There is still a long way to go for the country in order to reduce the overall risks associated with industrial agriculture in Libya. The country predominantly consists of desert lands and this means that there is very limited availability of natural resources for effective irrigation services. There is also an increased number of soil borne pathogens. Apart from this, there is the issue of salinity which impedes agricultural development (Suh, 2018).



Due to the low levels of availability of arable soil in Libya, the crops that are grown are mostly used for domestic consumption. Water is necessary for all plant life, but there are plants that are capable of living in dry and arid areas. In countries, where the rate of evaporation is very high and the soil is not suitable for agriculture, it is very difficult to grow many types of crops. Apart from this, the soil in different arid regions vary from each other and they only support the growth of a small range of crop types. One of the formidable challenges for farmers in arid regions such as Libya is that the salinity builds up in the soil and this increases the salinity of fresh water. This can affect the overall agricultural output. It is very important to make sure that various measures are adopted so that these challenges can be eliminated or avoided (Cristache, Vuță, Marin, Cioacă, & Vuță, 2018).

According to Campanhola (2019), the available natural resources available are being seriously depleted. Therefore, there is a need to develop and implement effective measures of sustainable development so that crops can be produced for the purpose of domestic consumption. Sustainable agricultural practices are important because they ensure that different natural resources such as air and water are used in the most optimal manner. This will ensure that these resources are available for future generations. In the context of Libya, the different sustainable agricultural practices can help in increasing the overall farm income as well as promoting awareness about protecting the environment. As a result, the overall production of human food as well as fibre are increased. Sustainable agriculture comprises of a wide range of production processes, that are organic as well as conventional. If Libya considers implementing sustainable agricultural practices, it will be able to restore the nutrients that should be available in the soil. Industrial farming cannot be carried out in Libya due to the poor availability of resources as well as a high rate of evaporation. Sustainable agriculture also helps in stabilising the food supply and at the same time support the different local communities in an effective manner (Holloway & Mengersen, 2018).

Strategies which can be adopted by the government of Libya to support sustainable agriculture practises

Sustainable agriculture refers to farming methods which are capable of producing sufficient food to mitigate the present food and textile shortages of a society, without compromising its ability to produce sufficiently for future generations in order to meet their needs (Singh & Yadav, 2020). There are some strategies that can be adopted by the government in Libya to support sustainable agricultural practices. Some of these strategies are provided below:

1. **Making use of renewable sources of energy** - This is a significant practice which helps governments in supporting sustainable agricultural practices. The use of wind farms, hydro power or solar power in sustainable farming is an eco-friendly way. Encouraging farmers to use solar panels in order to store solar energy as well as utilising it for electrical fencing and running heaters and pumps. Encouraging this practice can help in making agriculture more sustainable in Libya.
2. **Biodynamic farming** - This incorporates holistic growing and ecological practices on the basis of a philosophy of sustainability. This practice can be applied to farms which grow different types of produce, vineyards, gardens and other kinds of agriculture. This practice emphasizes the development of the fertility and health of soil for food production onsite by execution of practices like application of animal manure, composting, rotating



complementary crops or cover cropping (Ladha, Jat, Stirling, Chakraborty, Pradhan, Krupnik, et al., 2020).

3. **Farmer's education and empowerment** - This is another method or strategy that can be adopted by the Libyan government to support sustainable agricultural practices. It is very important to educate farmers properly and to engage with and empower them in the policymaking regarding making agriculture sustainable in Libya. This can highly contribute to the awareness of farmers regarding the practices which they can employ to make agriculture sustainable in Libya.
4. **Crop rotation** - This is a tested method which is utilised since ancient times in farming and is a proven method for keeping soil healthy and nutritious. In this method, crops are picked in such a manner that they are planted in one season to replenish salts and nutrients in the soil which were absorbed in a previous crop cycle. Encouraging crop rotation farming will help in making agriculture sustainable in Libya (Lal, 2019).

METHODS

The methods adopted by the researcher mainly focus on developing a better understanding of agriculture and sustainable development in Libya. The country faces many challenges due to the lack of appropriate conditions for cropping and agricultural activities.

There are three principal types of research methods that can be used by the researcher to obtain reliable results, namely qualitative, quantitative and mixed methods (Creswell, 2003). Which particular method is adopted depends largely on what knowledge the researcher is seeking. For the purposes of the current study, a qualitative method was adopted based on conducting semi-structured interviews. A list of interview topics was drawn up (copy available in Appendix) based on the main themes which emerged from the literature review. The research strategy which was adopted entailed conducting interviews with three farm managers and five employees at the Abu Aisha Agriculture Development Company in Libya. The selection of participants was made on the basis of purposive sampling of individuals with direct experience of farming in a rural area of Libya. The interviews were recorded in writing in Arabic and later written up in transcripts in English. The collected narrative data was then analyzed by thematic analysis. This permitted themes to emerge in such a way as to organize the narrative data by identifying principal insights from participants. The key findings are presented in the following section.

ANALYSIS AND KEY FINDINGS

The findings from the thematic analysis of the interview narrative data are discussed in this section by presenting the principal themes which emerged relevant to each interview topic.

Theme 1: The concept of agriculture and sustainable development in Libya

Interpretation

On the basis of data collected during the interview, an interpretation can be made that the concept of agriculture has been understood by the participants as a method of cultivating soil and



growing crops which comprises the preparation of the soil for planting by spreading natural animal manure. Further, in Libya the concept of sustainable development is related to the growing of crops and farming with best possible practises in such a manner as to meet current needs without sacrificing needs of future. Thus, the concept of sustainable agriculture is mainly associated with doing farming in such a manner which keeps a balance between social, environmental and natural needs through maintaining a balance in the ecosystem.

Theme 2: Concept of sustainable development has become so vital and important for countries like Libya

Interpretation

It has been ascertained that the concept of sustainable development has become so important and vital for all the countries including Libya as it encourages people and citizens of a country to conserve and enhance its resources base by the way of gradual change in such a way as to support improved practises for development without the exploitation and excessive use of natural resources. Thus, the concept of sustainable development is important for countries like Libya as it helps in meeting the needs of today without comprising needs of tomorrow through stabilising practises and reducing carbon emission and other forms of pollution for the protection of natural resources and of the overall environment.

Theme 3: Sustainable farming and its main benefits and importance for Libya

Interpretation

The viewpoint which was expressed by most participants was that the concept of sustainable farming saw understood to be associated with using and implicating agriculture practices while considering and keeping in the mind the complete ecological cycles and making them sensitive towards microorganisms. The main benefits and importance of sustainable farming for Libya comprises environmental preservation along with leading economic profitability through the most efficient use of renewable as well as non-renewable resources to the betterment of social and economic equity and effective development.

Theme 4: The main practise and strategies that can be adopted by farmers of Libya to ensure more effective way of sustainable farming

Interpretation

An interpretation of the narrative data is that the main practise and strategies that can be adopted by farmers of Libya is to ensure that more effective ways of sustainable farming consist of making use of renewable energy sources like hydro and solar power by farmers for running pumps and heaters. Further, making use of hydroponics and aquaponics techniques of farming is also taken as a main practise and strategy that can be adopted by farmers of Libya to ensure more effective methods of sustainable farming.

Theme 5: Making use of chemicals and other artificial techniques has led to the depletion of topsoil and the contamination of water



Interpretation

An interpretation has been made on the basis of the current investigation that the use of chemicals and other artificial techniques has led to the depletion of topsoil and the contamination of water as it leads to water and soil pollution and renders them contaminants unfit for future use. Thus, excessive use of chemicals makes soil unfit for future use and also pollutes the water and other natural resources.

Theme 6: Use of sustainable agriculture practices within the Libya

Interpretation

The thematic analysis of the narrative data revealed that the farmers and citizens of Libya are continuously supporting and making efforts for sustainable agriculture which consists of applying crop rotation on a continuous basis which is a sustainable way to keep soil healthy and nutritious for future use. Further, the use of polyculture farming along with permaculture are also effective food production systems which ensure the reduction of the wastage of resources along with increasing production efficiency which forms the main use of sustainable agriculture practices within Libya.

Theme 7: Various challenges and limitation are also associated with implication of sustainable agriculture in Libya

Interpretation

The biggest challenge and limitation that is faced by Libya while adopting sustainability agriculture consists of the fact that the physical and economic climate of Libya does not support healthy agriculture and also faces the disaster of the enforced emigration of workers from rural areas. Further, the conventional industrial farming adopted within Libya also underlies crop cultivation within Libya without emphasising and considering conservation rates which is also a big challenge and limitation for sustainable farming within Libya.

Theme 8: Main drawbacks and limitation faced by farmers and other associated parties while adopting and implicating the sustainable agriculture within Libya

Interpretation

The thematic analysis revealed that the increasing risk of erosion of topsoil along with overproduction of crop through the excessive use of fertilizers has affected the ecosystem which is the main drawbacks and limitation faced by farmers and other associated parties while adopting and implicating sustainable agriculture within Libya. Further, it has been interpreted that resource depletion, deforestation and land degradation are the main drawbacks and limitations faced by farmers and other associated parties while adopting and implicating the sustainable agriculture within Libya.

Theme 9: Various development plans and techniques which could be adopted by Libya in order to become agriculturally self- sufficient



Interpretation

The key findings from the thematic analysis reveals that polyculture farming is an effective development plan and technique which could be adopted by Libya in order for the country to become agriculturally self- sufficient which also leads to multiple crop species in one area along with leading high diversity. Further, use of permaculture is also an effective technique which provides an improved design and smart farming techniques could also be adopted by Libya in order for the nation to become agriculturally self- sufficient which ensures and leads to reduction in the waste of resources along with creating and leading production efficiency.

Theme 10: Sustainable agriculture structure present within the Libya

Interpretation

Sustainable agriculture within Libya was seen as comprising the transfer of certain crops like forage and wheat, to water abundant nations by bilateral arrangements of long-term investment. Further it has been also analysed that employing the comparative advantage of country in exporting the crops as well as value added commodities in order to maximize foreign earnings is also a current sustainable agriculture practice present within Libya.

Theme 11: Main aim and purpose behind the adopting of sustainable agriculture within Libya

Interpretation

An interpretation of the analyzed data relevant to this theme is that agriculture often places significant pressure on natural resources and the environment; thus, it becomes vital and important for farmers of Libya to come up with sustainable agriculture practices. Thus, it has been analysed that the main aim and purpose behind the adopting of sustainable agriculture within Libya comprises the fact that sustainable agricultural practices are intended to protect the environment, expand the Earth's natural resource base, and maintain and improve soil fertility.

Theme 12: The strategies and methods that can be adopted by the government of Libya to promote and support sustainable agriculture among framers of Libya

Interpretation

With respect to current investigation and collected data, an interpretation can be made that making use of renewable resources along with biodynamic farming are strategies and ways that can be adopted by the government of Libya to promote and support sustainable agriculture among farmers of Libya which incorporates holistic growing and ecological practices on the basis of a sustainability philosophy. Further, focusing on farmer education and empowerment along with supporting crop rotation strategies are methods that can be adopted by the government of Libya to promote and support sustainable agriculture among farmers of Libya.

Theme 13: Impact is lead out by agricultural development and sustainable practices on the overall productivity level of Libya

Interpretation

It was clear that most participants agreed that agricultural development and sustainable practices would lead to a positive impact on the overall productivity level of Libyan sustainable



agriculture as it aims at integrating the three main goals, i.e. environmental soundness, economic viability and social equity to bring an improved development and efficient productivity level. It is also evident that participants regard sustainable agricultural practises as focusing on diverse farming systems which use a variety of crops and the diversity of plants in this farming system ensures that they are more resilient to withstand any pests, diseases and drought thereby ensuring a positive impact on overall productivity levels within Libya.

Theme 14: Most vital sustainable and eco-friendly practices which can be adopted within Libya to have efficient development and higher productivity level

Interpretation

Most participants believe that agroforestry is a most vital sustainable and eco-friendly practice which can be adopted within Libya to have efficient development and higher productivity levels as it supports farming in dry regions and also with soil susceptible to desertification for leading long-lasting, productive, and diverse land use when approached sustainably.

DISCUSSION

Agriculture can be defined as the science of cultivating the soil and growing crops. In many countries, agriculture serves as the most important source of income (Janker, Mann & Rist, 2018). But in countries that have arid regions and are surrounded by desert, conducting agricultural activities can become difficult. This is because the rate of evaporation in these areas is high and also, the soil lacks nutrients (Kociszewski, 2018; Ladha, Jat, Stirling, Chakraborty, Pradhan, Krupnik, et al., 2020). Libya is a country that does not have good prospects for conducting various farming and agricultural activities. Therefore, the small amount of crops that are grown there are used for domestic consumption. The major crops that are grown in the country are olive, dates, barley and wheat (Kociszewski, 2018). The Libyan Government has invested significantly in improving agriculture. The number of women involving in agricultural activities in Libya is increasing and they are mainly looking after livestock although they do some soil preparation and planting. However, there are certain issues such as the lack of security and therefore, it is important to make sure that proper interventions take place.

There are many challenges that are faced by the respective country due to lack of appropriate resources for conducting agricultural activities. In Libya, various agricultural activities such as animal husbandry, cropping etc. are considered to be secondary. There are various agricultural challenges that countries with arid regions like Libya have to face. For example, the main challenge that the country has to deal with is that the soil is not fertile and the salinity level is also high. Such conditions are not suitable for growing crops. Apart from this, the resources for the availability of freshwater as well as rainfall are also minimal. The temperatures are extremely high and this means that it is difficult for the people living there to conduct various agriculture activities in an effective manner. The availability of resources is very limited which means that only a small range of crops can be grown there. Furthermore, farming is only limited to areas that have enough water to carry out irrigation process. As a result, the country has used various measures to conduct agricultural activities.



Desert farming is a practice of developing agriculture in areas where the land is arid and there is a scarcity of water (Holloway & Mengersen, 2018). The practice involves agriculture of crops that are well suited for dry and arid conditions. This practice helps in successfully growing crops for the consumption of local people. As of now, there are many countries, such as Libya, that are unable to support the growth of maize. Libya is not considered to be one of the countries that has soil suitable for the overall growth of food crops and, due to this, it is difficult to effectively cultivate crops. Libya has very low levels of rainfall and due to the current development under way in the country, the demand for natural resources has increased. Apart from this, the level of temperature is also high in the country which is not suitable for the growth of crops.

There are various surveys that have been conducted which show that there are many challenges that various communities face. In the context of countries within arid regions, there are different techniques that can be adopted by the country. For example, rotating crops as well as desert farming are some of the techniques that can be used (Ladha, Jat, Stirling, Chakraborty, Pradhan, Krupnik, et al., 2020). Apart from this, desert agroforestry is another useful technique that has been adopted by the country to enhance agricultural activities. The practice is important for countries such as Libya because it helps in the conservation of natural resources and also, the overall economic income of the rural people is increased. Agroforestry also helps in improving the food security of the country. This method involves low cost and the human impact on the land is also reduced. Farming activities in countries like Libya are mainly dependent on water, which is a scarce resource for the country.

Generally, agriculture is one of the most important sources of income for most countries. Many countries such as Libya face various challenges that affect the overall production of crops in the country. The reason for this is that the soil of these countries lacks many nutrients (Shahrajabian, Chaski, Polyzos, & Petropoulos, 2021) and the high temperature in deserts affect the quality of crops to a great extent. Therefore, it is important for the country to adopt various agricultural techniques that can help it in ensuring that crops are grown properly as well as successfully (Ladha, Jat, Stirling, Chakraborty, Pradhan, Krupnik, et al., 2020). Also, there are different challenges to sustainable development or agriculture that can affect the country to a great extent. This can include less water retention and loss of soil moisture as well. Such conditions have made it difficult for the country to conduct farming activities in an effective manner. This is because there are some crops that require a high percentage of nutrients as well as moisture to grow. Climate change is another factor that can act as a challenge for countries such as Libya to grow different types of crops.

In desert areas, the land available that is suitable for conducting farming activities is minimal. Hence, desert farming is a method that has been adopted by Libya to conduct its agriculture. Desert farming is used because agriculture is not very widespread in deserts as the water available is not adequate for growing different crops. Also, the soil available in such areas is infertile as well as dry. Such soils are not suitable for many types of crops. Agriculture plays a very important role in the overall economy of a country (OECD, 2011) and apart from providing food as well as raw material, agriculture also provides considerable employment opportunities as well. Sustainable development primarily focuses on enhancing the overall process of crop production in countries such as Libya. The country is working towards ensuring that there is an early recovery as well as rapid return to the different pathways of sustainable development. Another reason why sustainable development is important is because it enhances



the overall capacities of the local people and improves the basic service delivery of agricultural activities (Allen, Van Dusen, Lundy, & Gliessman, 1991).

CONCLUSION

From this study, it can be concluded that agriculture is an important source of income for the overall economy of a country. Agriculture in arid areas is very different and this is because the availability of the types of soil is very different from that of other regions. The different types of challenges can include loss of soil nutrients and the lack of moisture in the atmosphere. Also, high temperatures can contribute to the overall challenges facing the country. Therefore, it is important to make sure that appropriate strategies and techniques are adopted so that the farming activities are conducted in an effective manner. Desert farming can be defined as the process of conducting agricultural activities in desert areas such as Libya. Although the respective country Libya has a coastline, the available water is not sufficient for supporting the growing of crops or conducting agricultural activities properly. The availability of fertile soil in such areas is very limited and this is also an important issue. Therefore, sustainable development is one of the important strategies that should be implemented in such countries. The main crops that are grown in countries such as Libya are olive, dates, barley and wheat. It is somewhat difficult for such countries to grow other crops that require an increased level of moisture as well as fertile soil.

It can also be concluded that there are different sustainable techniques that a company can adopt to ensure the successful growth of crops. Desert farming is an important practice that is usually carried out in countries such as Libya. From this study, it can be concluded that the Libyan Government should ensure that it is able to grow suitable crops so that the farming activities are conducted in an effective manner. First of all, a sufficient supply of water for irrigation should be made and that crops receive adequate nutrients. The different challenges within arid regions can affect the overall quality of the crops that are produced. Also, erosion can occur and affect the topsoil of the region. A lack of forests is also a major challenge as the lands are barren. Therefore, by adopting effective techniques, such challenges can be countered and the overall quality of the soil can also be retained. Agroforestry is another technique that can be used for conducting farming and agricultural activities in the country or other regions that are dry and arid.



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APPENDIX

Interview questions

Q1) as per your view point, what is meant by the concept of agriculture and sustainable development in Libya?
Q2) As per your perception, Why the concept of sustainable development has become so vital and important for countries like Libya?
Q3) what is meant by sustainable farming and what could be its main benefits and importance for Libya?
Q4) What are the main practise and strategies that can be adopted by framers of Libya to ensure more effective way of sustainable farming?
Q5) Are you agreed with the fact that making use of chemicals and other artificial techniques has led to depletion of top soil and contamination of water?
Q6) Are you having any perception and view point about the use of sustainable agriculture practices within the Libya?
Q7) Are you agreed with the fat that various challenges and limitation are also associated with implication of sustainable agriculture in Libya?
Q8) What could be the main drawbacks and limitation faced by farmers and other associated parties while adopting and implicating the sustainable agriculture within Libya?
Q9) What information are you having about the various development plans and techniques which could be adopted by Libya in order to become agriculturally self- sufficient?
Q10) what perception you are having about the sustainable agriculture structure present within the Libya?
Q11) What is the main aim and purpose behind the adopting sustainable agriculture within Libya?
Q12) What implication are you having about the strategies and ways that can be adopted by the government of Libya to promote and support sustainable agriculture among framers of Libya?
Q13) What overall impact is lead out by agricultural development and sustainable practices on the overall productivity level of Libya?
14) what are most vital sustainable and eco-friendly practices which can be adopted within Libya to have efficient development and higher productivity level?