REVIEW ARTICLE

Achieving food security in the Kingdom of Saudi Arabia through innovation: Potential role of agricultural extension

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Abstract In the Middle East, especially Saudi Arabia, food security will be a matter of concern for policy makers. In desert countries the food commodities are mostly imported from other countries as their local production is not enough to meet the domestic needs and Saudi Arabia has no exception. Most of the cereals and red meat are imported. Major limiting factors in agriculture production are land and water, such that by 2050, Saudi Arabia is expected to import all of its domestic needs. Meanwhile, there are many land and water saving technologies which have the potential to help produce enough to meet the domestic energy requirements. Promotion of traditional crops, hydroponics and greenhouse farming, seawater harvesting, investing in bio-salinity research and rainwater harvesting are among those technologies. Therefore, role of extension agent is critical to promote the innovative technologies as well as creating awareness among farming community to implement the guidelines to meet the country dietary needs. This paper suggests substitute expertise and methodologies that can be engaged by Saudi Arabia under prevalent situation, which can be helpful to expand national food fabrication to achieve food security in the Kingdom. Efficient role of agriculture extension is need of the hour that should be exploited and utilized in a precise and efficient manner. All the possible strategies related to agricultural extension for prevailing agricultural challenges in the Kingdom are discussed in detail.

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1. Introduction

The Kingdom of Saudi Arabia (KSA) covers approximately an area of 2,149,690 square kilometers (World Bank, 2015), home of 30.77 million people (Ministry of Economy and Planning, 2014). It covers the predominant (80%) area of the Arabian region (Al-Hamzi, 1997), which makes it the largest country of the Gulf region. It has shared borders with Qatar, United Arab Emirates and Bahrain in east; with Iraq, Kuwait and Jordan in the north; with sultanate of Oman and Yemen in south; and has 1750 km Red Sea shoreline in west (FAO, Jordan in the north; with sultanate of Oman and Yemen in south). Hence, the rate of which averaged 5% per annum over the period (Ministry of Agriculture, 2008).

Agriculture is the base on which the economic strength of a country relies. If the agricultural practices are not enough to become self-sufficient in food production, the strength of the country will be at risk. Therefore, self-sufficiency in food production could only be gained by addressing the agricultural problems and keeping the farmers aware of modern agricultural technologies, necessary for improving productivity, by the effective use of extension services. Agricultural extension is considered as a service to spread/extend information based on research, to the rural people to develop their living standard (IFPRI, 2010). Hence, it includes components such as technology transfer, wider rural development objectives and non-formal education (Birner et al., 2009; CTA, 2012). In this article, an effort has been made to identify problems and devise a solution to assist policy makers and farmers through the channel of agriculture extension.

The General objective of the present study was to examine the present situation of food security in regard to agricultural production and consumption. Specific objectives are to identify and analyze (1) the modern resource efficient agricultural technologies, (2) their possible contribution in achieving food security with available resources, and (3) the potential contribution of agricultural extension and education for sustainable farming in the Kingdom.

2. Saudi Arabia’s present and future needs to boost domestic production without utilizing desert agriculture

The Kingdom of Saudi Arabia’s present and future needs to expand domestic production without utilizing desert agriculture are limited by land and water scarcity. The available water resources of any country are key elements in agricultural production. Saudi Arabia fall in the category of countries which will face acute water shortage by 2050, as depicted in Fig. 1.

In Fig. 1, green color depicts the countries having surplus water (> 1300 cubic meter), and orange and red color shows countries facing challenge of freshwater shortage (< 1300 cubic meter) per capita per year. The kingdom has 3850 cubic meters per year available groundwater, whereas, the surface...
water is 1300 cubic meters per year, which is variable and depends on annual rainfall. The kingdom’s estimated total renewable water resources are about 500 km³, 340 km³ of which is economically feasible to extract. The kingdom consumes 24 billion cubic meter water per year, and agriculture is the leading sector with 88% usage, municipal sector 9% usage (Al-Hussayen, 2007), and industrial sector accounts 3% usage of total water consumption. On an average, the municipal sector consumes about 260 liters water per capita per day (World Bank, 2010). The major water demand of about 65% for municipal and industrial sector is used to be supplied with groundwater while the 35% leftover is met by desalination water treatment plants. The available data of 1999–2004 show an increasing trend in rural to urban migration coupled with 3% population growth which had increased 4.3% municipal water consumption (Ministry of Economy and Planning, 2005). The available water resources shows that Saudi Arabia will not be able to meet the domestic food demands making it a food importing country. To irrigate municipal parks and street landscape the treated wastewater is abundantly used. On country basis survey during 2010, approximately 240 million cubic meters per year wastewater after treatment was used for landscape and crop irrigation (MWE, 2012). The data in Table 1 show the sustainable yield of water from non-conventional and conventional sources and, water demand of major water consuming sectors. The gap between supply and demand is about 11.5 billion cubic meters per year, which was overcome by overexploitation of groundwater.

3. Water and land saving technologies

Water and land saving technologies (conventional and non-conventional) are technologies which are utilized to produce the same yield, without mounting pressure on nonrenewable resources. These innovative technologies have potential to boost agricultural production from the same crop land under cultivation, which is 1.8% of total area of the Kingdom. These water and land saving technologies include the following.

3.1. Promoting conventional crops

Promotion of conventional crops (wheat, barley, sorghum and millet, etc.) which are best suited to the arid climate conditions helps to achieve food security (FAO, 2008). Dates are one of the best productions of Saudi Arabia; therefore, it is need of hour to explore more avenues of research (Mbaga, 2013). Table 2 describes the availability of different food products in the Kingdom. As mentioned, cereal production in Saudi Arabia escalated at maximum position ever recorded, 1,570,944 tonnes from an area of 286,932 hectares. Wheat production gradually decreased as shown in Table 2. Wheat is the staple food and its import puts a lot of pressure on Kingdom

<table>
<thead>
<tr>
<th>Sustainable water yields</th>
<th>Capacity (million m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>3850</td>
</tr>
<tr>
<td>Surface water</td>
<td>1300</td>
</tr>
<tr>
<td>Total conventional Sources</td>
<td>5150</td>
</tr>
<tr>
<td>Treated wastewater</td>
<td>240</td>
</tr>
<tr>
<td>Desalinated water</td>
<td>1050</td>
</tr>
<tr>
<td>Total non-conventional sources</td>
<td>1290</td>
</tr>
<tr>
<td>Total water yields</td>
<td>6440</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Water demand per sector</th>
<th>Capacity (million m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>15,000</td>
</tr>
<tr>
<td>Industrial</td>
<td>800</td>
</tr>
<tr>
<td>Domestic</td>
<td>2063</td>
</tr>
<tr>
<td>Total water demand</td>
<td>17,863</td>
</tr>
<tr>
<td>2010 Water demand vs. supply gap</td>
<td>11,423</td>
</tr>
</tbody>
</table>

* Depends on annual rainfall pattern.
So, there is a need to focus on agricultural research and extension activities to reduce the import burden.

3.2. Hydroponics and greenhouse farming

Hydroponic and greenhouse technologies require nutrient rich water for plant growth instead of soil (Bridgewood, 2003). Hydroponics help to produce high quality vegetables and fruits in controlled environmental conditions around the year. This technology is environmentally safe, high producing and reduces the pressure on land and water. The average vegetable yield in the field is about 5 tons per acre, but the hydroponic technique in the greenhouse makes the yield increase up to 200 tons for each acre planted. Vegetable production under green house technology in Saudi Arabia for the years 2010–13, showed a significant increase in area under production as well as in total production, over time, especially for tomato and cucumber crops (Table 3). It has been reported that hydroponic green fodder production technique requires only about 2–10% of the water needed to produce the same amount of crop in soil culture (Brandlay and Marulanda, 2000). Moreover, only 3–5% of water is needed to produce the same amount of fodder in comparison with that produced under field conditions (Ghazi and Al-Karaki, 2011). Hydroponic system, therefore, is a potential technique for food production with less water consumption where water is the main limiting factor for agriculture production.

These technologies have also been implemented in other parts of Arab region e.g. Al Sulaiteen Agricultural and Industrial Complex, Qatar: a modern greenhouse farm in the middle of a vast desert. This farm produces cucumber, tomato, green beans, cherry, vegetables and many fruits. United Arab Emirates had also made an investment in hydroponics that are playing a key role in their local markets. Similarly, Abu Dhabi has taken the initiative by establishing Emirates Hydroponic Farm in 2005, which had started to produce for domestic needs and regional demands. The produced food items such as lettuce, strawberries, cucumber and capsicums that are started to sell out online are having similar price to those of the supermarkets. Organic mushrooms were grown by Emirates Mushroom a private company having production of 8000 kg per week from ten specially designed rooms. In Baniyas, largest aquaponic center of world launched by Abu Dhabi, the project was started by growing lettuces and expanded for vegetable production. In Aquaponics, the vegetable uses nutrient enriched water with fish that are living in, as depicted in Fig. 2.

3.3. Investment in biosalinity research

Nearly 97.5% of global water is salty (Taha and Ismail, 2011), suggesting that investment in biosalinity research is a useful tool in the arena of research. The plants face soil salinity as

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**Table 2** Production of cereals in different years from total estimated area under cultivation. Source: Ministry of Agriculture (2013).

<table>
<thead>
<tr>
<th>Estimated area under all crops (ha)</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated area and cereals production (ha)</td>
<td>Production (tonnes)</td>
<td>Production (tonnes)</td>
<td>Production (tonnes)</td>
<td>Production (tonnes)</td>
</tr>
<tr>
<td>Total</td>
<td>286,932</td>
<td>260,312</td>
<td>212,156</td>
<td>166,005</td>
</tr>
<tr>
<td>Wheat</td>
<td>219,505</td>
<td>192,818</td>
<td>144,169</td>
<td>102,613</td>
</tr>
<tr>
<td>Barley</td>
<td>2366</td>
<td>2270</td>
<td>2044</td>
<td>1502</td>
</tr>
<tr>
<td>Sorghum</td>
<td>43,899</td>
<td>44,399</td>
<td>45,438</td>
<td>42,101</td>
</tr>
<tr>
<td>Maize</td>
<td>14,951</td>
<td>15,302</td>
<td>15,528</td>
<td>15,626</td>
</tr>
<tr>
<td>Millet</td>
<td>3448</td>
<td>3086</td>
<td>2844</td>
<td>2632</td>
</tr>
<tr>
<td>Other cereals</td>
<td>2763</td>
<td>2437</td>
<td>2133</td>
<td>1531</td>
</tr>
</tbody>
</table>

**Table 3** Vegetables production in green house farming. Source: Ministry of Agriculture, 2013.

<table>
<thead>
<tr>
<th>Area and production of vegetables in green house</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (ha)</td>
<td>Production (tonnes)</td>
<td>Production (tonnes)</td>
<td>Production (tonnes)</td>
<td>Production (tonnes)</td>
</tr>
<tr>
<td>Tomato</td>
<td>3848</td>
<td>3842</td>
<td>4027</td>
<td>3947</td>
</tr>
<tr>
<td>Cucumber</td>
<td>2641</td>
<td>2654</td>
<td>2664</td>
<td>2605</td>
</tr>
<tr>
<td>Squash crop</td>
<td>193</td>
<td>201</td>
<td>197</td>
<td>189</td>
</tr>
<tr>
<td>Other vegetables</td>
<td>1147</td>
<td>1297</td>
<td>1310</td>
<td>1187</td>
</tr>
</tbody>
</table>

![Figure 2](image-url): Thematic aquaponic structure derived from Salam et al. (2014).
a major barrier for spreading into their natural habitat. Arid and semi-arid regions are increasingly facing this problem (Shanon, 1986). The earth’s 40% area came under arid and semi-arid regions (Fisher and Turner, 1978). Biosalinity is the practice and study in which saline (salty) water is utilized for irrigating crops. Freshwater resources are very scarce in Saudi Arabia and country has no surface water bodies of any kind excluding the Red Sea and the Persian Gulf, which cannot be utilized in agriculture except after going through an expensive desalination process (Al-Zahrani and Baig, 2011). In Saudi Arabia, the abundant quantities of available water are either brackish 500–30,000 ppm or saline 30,000–50,000 ppm (SWCC, 2010). Saline water utilization in traditional farming practices results in soil salinity and many crop plants become unable to grow.

Biosalinity research embraces studies of physiological and biochemical mechanism in plants for salt tolerance, selection and breeding for salt tolerance, use of saline irrigation water to increase desirable traits or to control the ripening process in fruits. The objective of biosalinity research is to deal with issues related to the interaction among salinity and soil properties than introduction or development of salt tolerant varieties, which sustain and remain economically productive. This type of research is needed for Saudi Arabia, which helps to maximize the agriculture production by utilizing the available saline water. There are some studies conducted on biosalinity in Saudi Arabia (e.g. Qados, 2011) but more deeper and applied research is required.

3.4. Seawater greenhouses

The seawater greenhouse technology can be utilized in desert regions of the world, which possess a huge quantity of seawater. The salt water is used to grow food crops through building these greenhouses near coastal areas (Reuters, 2007). It requires low cost as they are not expensive like desalinization plants (see Fig. 3).

Seawater is evaporated which makes the air saturated, condensed for freshwater that is used for watering the plants. This technology has the potential to be utilized in far flung and arid coastal areas because the process in the seawater greenhouse creates temperate conditions by making use of seawater and sunlight, which produce cooler air and water for cultivation of plants (Kabeel and Almagar, 2013). The favorable geographical and climatic conditions, such as access to cool seawater and low relative humidity are frequently found at a depth in the sea. The KSA coastline along Red Sea has many locations having the same properties (Paton and Davies, 2006). The seawater greenhouses get water from sea and building cost is more or less than $5 for a square foot.

The air inside the greenhouse is humidified through vapors that are produced from honeycomb like structure on the front wall, from where water trickles down. The air becomes warmer as it moves in the greenhouse and absorbs more moisture, and the second evaporator makes the air supersaturated. From there, air goes down into the condenser, and the freshwater produced is stored in the underground tanks that are later on utilized for watering plants.

3.5. Rainwater harvesting

The Arab region of the world is facing severe shortage of water. Main factors contributing their part in water scarcity are rapid population growth, improper distribution of water resources, increase in demand of water, hydro-political condition, deteriorating water quality, low rainfall, high rate of evaporation and aridity. The crisis of water is rapidly growing as per capita water availability is decreasing. The continuous increase in freshwater demand in the Arab world is putting pressure on scarce water resources, especially groundwater which will not sustain under the prevailing circumstances. There is a dire need to manage the potential of available water resources by more effective and efficient means. The region gets 2238 billion cubic meters per year rainfall, which, contribute only 200 billion m³ to renew ground and surface water resources. Ultimately, water harvesting is the only solution to cater water shortage as different water harvesting techniques are widely employed by the people of this region since a long time ago. The annual average rainfall ranges between 70 and 130 mm except some locations of Oman, Yemen and Saudi Arabia. Water harvesting employs the strategy of capture, diverting and storage of rain water for multiple use (Abdo and Eldaw, 2004). Three common landscape elements must be considered in rain water harvesting: soil condition or landscape runoff, variation in elevation that creates flow in water and enough deep soil horizon for collection of rain water. It
comprises of all methods through which rainfall and runoff are effectively managed for lateral use. The Ministry of Agriculture and Water had given this issue a great importance. The collective number of different constructed dams reached at 215 at the end of 2003 from which majority is embankment dams 58.5% and remaining are concrete. The collective storage capacity of dams touched 833 million m$^3$ (Table 4). The largest dam with 103 m height and 325 million m$^3$ storage is a King Fahad’s dam located in Wadi Bishah of Kingdom. From previous decade to present, three times more water quantity from 1400 to 3000 million m$^3$ has been increased.

Similarly, in arid parts of Tunisia much funding had been allocated to store and utilize precious rainwater (100–230 mm/year) for domestic, agriculture production and environmental needs.

4. Food security overview in the Kingdom of Saudi Arabia

According to FAO, food security can be defined as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2010).

4.1. Determining Kingdom’s domestic energy requirements

Protein and energy needs are defined as the amount required to sustain health, growth and suitable level of physical activity. These requirements are interrelated, if the dietary needs are fulfilled by conventional way to combat food security issues. Meanwhile, alteration in food consumption behavior affects metabolic activity and body size. The Saudi population energy requirements were estimated by body weight, population structure, Basal metabolic rate (BMR) calculation and pattern of physical activity. The estimated per capita energy requirement was 2100 calories per day (Table 5). These findings can be used in monitoring food balance sheets, national food policies and different economic index.

4.2. Body weight and population size

The calculated population of KSA is approximately 30 million, of which approximately 20 million are Saudi nationals and remaining are foreigners (Ministry of economy and planning, 2014). The United Nations Organization (UNO) estimates for population projection (1950–2015) were based on demographic information i.e. urbanization, mortality, fertility, population growth and across the boundary migration. Energy and protein requirements are directly related with body weight. The data on height and weight of Saudi Arabia residents were gathered by Food Policy and Nutrition Division of FAO that can be utilized for future energy requirements.

4.3. Current per capita energy requirement and domestic agriculture production

The available information on human dietary needs is recommended by national and international organizations, with regular interval on a scientific basis. Human dietary needs differ from one place to another and information about these needs is a prerequisite for future planning. The planning is based on individual consumption behavior, national nutritional needs, food supply pattern, standard food assistance plans, nutritional awareness programs and innovation in the food industry. The estimated per capita energy requirement ranges between 1870 kcal and 2290 kcal per day. The men (65 kg) and women (56 kg) of Saudi Arabia involved in light, moderate and heavy physical work were estimated as having 2595 kcal and 2050 kcal, 2975 kcal and 2150 kcal and 3515 kcal and 2400 kcal per day respectively (data not shown). The per capita availability of energy (Table 5) shows that there is a vast difference between available and required energy per capita, which means, people living in the kingdom are not food secure that is an alarming situation. To overcome the food security issues there is a dire need of multipronged approach for a country which is difficult to sustain on imported food.

5. Saudi Arabia’s future investment opportunities

5.1. Saudi Arabian agriculture development fund

The Saudi Arabian Agricultural Bank was established by Royal Decree No. (58) and the date of 13/8/1962 to be a credit institution-governmental organizations specialized in various fields of agricultural activity financing in all regions of the Kingdom, to assist in developing the agricultural sector and increase in production efficiency by using the best of modern scientific and technical methods. So it provided interest-free soft loans to farmers to secure the necessary activity such as machinery, pumps, agricultural machinery and equipment, cat-
tle, poultry, sheep, bees and equipment for Fish breeding and other breeding. On 26 January, 2009, the bank was approved by the Council of Ministers, after consideration of the Shura Council resolution No. (106/71) dated 8 April, 2008 on agricultural development fund systems attached to the resolution. Among the most prominent features of system, the funds of 20 billion riyals were increased with more amount by the decision of Council Ministers, took account of water conservation and rationalization of agricultural uses and preservation of the environment, the fund aims to support agricultural development and sustainability by providing soft loans and credit facilities necessarily.

5.2. Investment in abroad

In January 2009, King Abdullah announced the establishment of an “Initiative for Saudi Agricultural Investment” aimed both at cutting down Saudi agricultural production and investing in countries that had agricultural potential but with little financial means. The government announced an aid package worth $800 million for companies that invested in agriculture outside Saudi Arabia, pledging further support for the purchase of tractors and chemicals, the establishment of irrigation systems, and more in these countries.

5.3. New wheat silo projects

Over the past few years, several new wheat silo projects have been initiated. By December 2015, these storage facilities were slated to yield additional wheat storage capacity of about 3.7 million tons (MT) on top of current GSFMO silos that have a combined storage capacity of 2.8 MT. Saudi Grain Silos and Flour Mills Organization (GSFMO) also signed contracts to build five additional storage projects in Mecca, Jazan, Hasa, and Qassim with a combined storage capacity of 790,000 MT, which were to be operational by the end of 2014. Storage silos may not be cheaper to build and manage, but they are still much less expensive than growing cereal in such a harsh climate. Annual storage costs for wheat in Saudi Arabia are about $70 million, a minute figure in comparison with the cost of production subsidies, estimated at around $5 billion a year in 1984–2001 (Mousa, 2014).

6. Possible role of agricultural extension department

6.1. Sustainable agriculture

Agricultural extension is a formal and non-formal educational function that applies to disseminate information and advice with the intention of promoting knowledge, attitudes, skills and aspirations (Anderson and Feder, 2004). Nowadays, extension activities solely depend on extension agents, as farmers are the recipient and information is transferred through one way process. To achieve sustainable agriculture development there is a dire need of effective extension coordination, efficient extension services and professional extension agents (Shalaby et al., 2010; Dragic et al., 2009). The Kingdom of Saudi Arabia has very limited cultivated land and freshwater...
resources, so there is a need to create awareness among both the farmers and extension agents about the concepts and practices of sustainable agriculture and innovative technologies as discussed earlier in the above sections.

Environmental protection and resource conservation have been the highlighted objectives of National Development Strategies in the KSA. In this context, extension education is considered as vital in country’s development plans, which provides a number of services to the target communities by undertaking multiple activities for the betterment of farming and rural community. This sector is expected to update the farmer’s indigenous knowledge regarding conventional crop, land and water management, value addition of farm production, packaging and storage and further to create awareness about the marketing of agricultural commodities (Adejoh and Adah, 2012; Al-Zoubi, 1997). Besides that, an extension agent has to advocate the state policies regarding sustainable and profitable agriculture to combat food security, and facilitation of farmers in obtaining farm machinery, inputs and credit loans (Al-Shayaa et al., 2012). Prosperous agriculture in the Kingdom will definitely require the educated farming community with updated knowledge (Fiaz et al., 2016) and facilitation in the inputs required for whole farming process, comprising fixed and variable inputs as well as soft interest-free loans (Muddassir et al., 2016).

6.2. Capacity building

In Saudi Arabian agriculture system, Ministry of Agriculture is the prime body responsible for the policy making and its execution; further providing resource funds for research and its implication as outreach at the farmer’s doorstep (Royal Embassy of Saudi Arabia, Ottawa, Canada, 2010). At present situation, there is a need to create the awareness about the sustainable as well as conservation agricultural techniques to the farming community of the Kingdom, for efficient use of natural resources. Here comes the significance of the extension department in the Kingdom to initiate this awareness among community, which requires to evaluate the existing knowledge level of farmers about advancements in agriculture and their adoption level (El-Hag, 2008). There is very less reported studies which do evaluations like these, as by Al-Subaiee et al. (2005) and Al-Subaiee (2006). Among the awareness level, a package of advanced and improved agricultural technologies (land preparation, cultural, protection, post harvesting, value addition and marketing facilities) should be devised prior to disseminate this information among the farmers by capacity building. This requires the efficient infrastructure of extension and outreach departments of the Kingdom, with agents having good command on the communication skills as well as sufficient knowledge about site specific production technologies of the intended crop species to be discussed (Swanson, 2006).

6.3. Potential role in food security

Main issues the Kingdom is facing now are the limiting water (freshwater) and land resources, and prerequisites of agriculture (Fig. 4). According to an estimate by UNDP, 89% of freshwater is spent in agriculture sector, while 57% is from...
non-renewable aquifers (UNDP, 2010). Therefore, it is required to devise/introduce the resource use efficient techniques, plant germplasm and equipment that can help the Kingdom in a better and prosperous way. The agricultural extension department can play a significant role in ensuring the food security of kingdom by educating the farmers about judicious use of farm inputs and further cultural practices. The horizontal rise in agricultural production is almost impossible because of the rapidly increasing world population (Noor et al., 2018; Sahara Forest Project, 2012). Similarly, establishment of model plots is a way to depict the integrated application of all agronomic and protection measures as a component of sustainable and precision agriculture. Other tasks which can be performed by the extension department includes, possible engagement and cooperation of stakeholders from the agriculture sector, to launch the development and non-profit projects empowering the rural community by capacity building and small and medium home based industry in the villages of the Kingdom of Saudi Arabia. By this deep interaction, extension agents can better realize the reality and grass root problems of farming community and will be in a position to provide feedback to the policy institutions, research and university authorities to provide the immediate solution for reported drawbacks. Furthermore, a better feedback from the extension agents can help the agronomists to develop the site specific production technologies comprising a complete package of cultural and chemical control of the specific climatic/agro-nomic region of Saudi Arabia.

Better contribution of the extension department in food security requires a set of reforms comprising a nationwide policy planning that can be implemented. Another positive approach is to integrate the food security problems into agricultural research. Moreover, the behavior and attitude of extension agents toward the farmers must be encouraging and exclusive of personal biases and status values. Similarly, one of the food security challenges is to facilitate the process in seeking access to capital through various credit schemes.

7. Conclusion

The Kingdom of Saudi Arabia had experienced remarkable social and economic development in the last few years. The available food supply from domestic production with limited land and water resources is far less than the domestic daily requirements, seriously limiting the agricultural production. A sustainable increase in agricultural production can be achieved by the improvement in land and water productivity. There is a vast gap between demand and production of agricultural products which must be filled through the adoption of traditional and modern technologies i.e. land and water saving approaches and greenhouse farming, seawater harvesting and introduction of hydroponics and Aquaponics. If same trend remains active then the country will suffer from a serious setback as it is heading to become a major food importing country which will create a huge burden on the national treasurer. The need of hour is to become food secure country by utilizing some of the major techniques discussed above. To minimize the economic and social cost of diet related products, it requires to formulate the national policy integrated with all the possible solutions of food supply and nutritional status. Efficient role of agriculture extension is the need of the hour that should be exploited and utilized in a precise and efficient manner. Target assignments for agents include evaluation of farmer’s existing knowledge, creating awareness and motivation, capacity building and education, site specific technology transfer and awareness about judicious use of inputs especially freshwaters. Ultimately, feedback of ground realities from the extension department will help the policy makers to plan the agricultural policies for the Kingdom accordingly. Finally, we can conclude with four potential agricultural extension categories, namely, informal education, technology transfer, advisory services, and facilitation extension, which can be implemented and practiced in a dynamic way to achieve the set goals regarding sustainable agriculture and food security in the Kingdom of Saudi Arabia.

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