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Enhancing Water Productivity and Unit Efficiency in Dry Regions of Palestine

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Abstract

Payments for irrigation water (PIW) have gained popularity as an effective approach for protecting and restoring active ecosystems and watershed services. However, the emergence and persistence of these innovative financing tools and governance systems remain poorly understood. Water resources in Palestine are limited and scarce. As a result, there is a growing discussion about "adaptation" in development planning. This is seen to reduce risks associated with resource scarcity, environmental change, and the effects of climate change. The available resources are becoming increasingly limited and require careful management. The purpose of this study is to develop policies and methods for addressing water crises in dry areas. This will involve identifying the technical, social, economic, and political challenges associated with water scarcity and sustainable water management. To accomplish this, we will rely on secondary data and literature reviews from international sources such as ICARDA, as well as national experiments like NARC. We will also collect secondary data from previous studies and analyze the results to gain a better understanding of our strengths and weaknesses. By taking this approach, we hope to develop effective solutions to managing water resources in dry areas. A comprehensive study was conducted to examine the current state of water scarcity in dry areas, with a particular focus on Palestine (WBG), under different water conditions. The findings indicate an urgent requirement for more information and data on the characteristics of various water management methods to assess the water status and devise national water strategies for the inhabitants of (WBG). The study also delved into elucidating policies and adaptation techniques for agriculture in dry areas, grappling with a shortfall of water resources.

Keywords: Palestine, Dry Areas, Water, ICARDA, NARC, Environmental.

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Introduction

In the realm of food security and agricultural water management, robust policies are indispensable for the growth and prosperity of nations, especially in dry areas where water scarcity is already a pressing issue (Lu et al., 2015; Magidi et al., 2021). Unfortunately, there are millions of people around the world who are unable to sustain their livelihoods due to a lack of adequate water supply. This dire situation has seriously hampered their chances of escaping poverty. Therefore, it is imperative that we address this critical water shortage with utmost urgency to uplift the lives of these individuals and foster economic development (He and Lorenzo., 2023; Musie et al., 2023; Mahmoud et al., 2024). The intricate correlation between poverty and water is a convoluted matter, yet the significance of water as a valuable resource necessitates responsible management to ensure its long-term sustainability for forthcoming generations, as per Pimentel et al. (2004). The indispensability of water for life cannot be emphasized enough, and an adequate supply of water for agriculture and domestic purposes is an indispensable prerequisite for human and economic development. It has been widely recognized that human behavior can have a profound impact on water and the global ecosystem, thereby making it imperative to regulate human behavior to stabilize and sustain our future. In the Palestinian Territories, water is the most precious natural resource, and its relative scarcity poses a formidable obstacle to economic development. The equitable distribution and management of water resources among Palestinian households and landowners is a pivotal matter that demands careful consideration in the ongoing multilateral peace negotiations regarding water rights (Oweis, 2010). The water resources in Palestine are not only limited but also scarce. The Israeli government's stringent regulations on Palestinian water utilization and their persistent denial of access to groundwater aquifers, including the Jordan River, have led to a significant reduction in the quantum of water available. The dearth of permits for constructing water reservoirs and structures to capture runoff water has further exacerbated the problem of utilizing rainwater, particularly in recent times. Presently, Palestine's fresh water supply emanates from just four primary water aquifers (MOA, 2019).

The aqueous content from these subsurface reservoirs is conveyed to the surface via wells or natural springs. Given the acute dearth of water in agriculture, the Palestinian populace has fashioned techniques to circumvent this predicament. These techniques encompass a variety of water management systems and informal methodologies, including the implementation of active policy measures pertaining to rainwater harvesting, as posited by Gemma et al. in their 2011 study. In the realm of development planning, the discourse around "Adaptation" has gained significant momentum to mitigate the hazards presented by resource scarcity, environmental degradation, and most notably, climate change. It is becoming increasingly clear that limited resources exacerbate these challenges, thus necessitating the adoption of adaptive measures. Our study follows the first study and aims to search types of integration about water management policies in dry areas, by Explaining some policies, and methods of adaptation for agriculture in the dry environment for facing water scarcity, highlighting Maximizing

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management for water quantities available: where first study interested in water supply management, and our objectives now managing of water demands available by offering a lot of methods and tools can help the interested decision-makers after Putting the qualitative results in front of them, planners', and farmers to evaluate their acceptance for adoption the suggestion methods and regulations, By optimizing the utilization of available water resources through the implementation of appropriate agricultural investments and diversification of species, we can enhance the efficiency and yield of farm investments. This can be accomplished by ensuring that investments are aligned with the amount of water supplied, taking into consideration the appropriateness of different plant and animal species. (ICARDA, 2010). The study will explain the water status in the world, obstacles, and the Scientist's vision to manage developing water scarcity in dry areas and will explain Some innovations for the management of Pasture and desert development. In addition to explaining the useful methods to producing according to what you need and what you have from water, where importing several experimental stations results related to the International Center for Agriculture in Dry Land (ICARDA), focusing on producing multiple crops efficiently within one cubic meter to meet our needs and strategies for weight, calories, protein, and price.

After conducting an extensive study, it can be concluded that further research is needed to fully understand how water management policies can aid in developing the agricultural sector under conditions of scarcity. This requires a multidisciplinary approach that considers both social and technical aspects of the problem. The goal is to present these findings to policymakers and donors in a manner that ensures the continuous and sustainable use of resources. The issue at hand is complex and will require a great deal of expertise and qualified studies to address.

Palestine in this Study

This research project was carried out in the Palestinian Authority (PA), formerly known as the West Bank and Gaza (WBG), as part of the Oslo Agreement in 1994. Historically, the region of Palestine covered an area of approximately 27,000 km^2, extending from the Mediterranean Sea to the Jordan River. However, a significant portion of this land was occupied by Israeli Zionists in 1948, while Palestine was still under British mandate. The remaining area, including the West Bank (including East Jerusalem) and the Gaza Strip, was occupied during the 1976 war between Israel and Egypt. Currently, the West Bank is estimated to cover an area of 5572 km^2, while the Gaza Strip is approximately 367 km^2. According to the latest population projections from the Palestinian Central Bureau of Statistics (PCBS) in 2022, the WBG is home to around 4.17 million people, with 3.25 million residing in the West Bank and 2.3 million in the Gaza Strip.

Palestinian Water Resources

Israeli consumers enjoy an abundance of water while their Palestinian counterparts face a dire shortage of basic resources. Incontrovertibly, Israelis have access to about four times more water than Palestinians. Israel has exclusive access to the Jordan River water, while Palestine is left with nothing. The distribution of the coastal aquifer is heavily skewed, with Israel enjoying 82%

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of the access and Palestine a mere 18%. The mountain aquifer is no different, with Israel holding 83% of the access and Palestine only 17%. And to add insult to injury, Israel monopolizes all other sources of water, leaving Palestinians with no access at all. It's worth noting that Palestinians only consume an average of 56 liters per day, which is a mere 55% of the WHO recommended minimum of 100 liters per day (Mizyed, 2013). The annual precipitation in Palestine amounts to approximately ten thousand million cubic meters, however, a mere 20% of this volume proves beneficial by percolating into the ground, while the remaining 80% is lost due to evaporation (60-70%) or swiftly flows towards the sea (PCBS., 2019). The estimated average annual groundwater recharge within Palestine's borders ranges between 698 to 708 million cubic meters per year. Of this, about 648 million cubic meters per year are recharged in the West Bank and 50-60 million cubic meters per year in the Gaza Strip. It is worth noting that the Jordan River serves as the only source of surface water in the West Bank (Haddad, 2011).

Objectives

The primary objective of this study is to devise policies and methods to combat the water crisis prevalent in dry areas. Through this study, we aim to identify the technical, social, economic, and political challenges that impede the sustainability of water management practices. Our goal is to devise innovative solutions that can effectively tackle these challenges and ensure the efficient and sustainable management of water resources in these regions. Our study follows the first study and aims to search types of integration about water management policies in dry areas, by Explaining some policies, and methods of adaptation for agriculture in the dry environment facing water scarcity, highlighting Maximizing management for water quantities available: where the first study interested in water supply management, and our objectives now managing of water demands available by offering a lot of methods and tools can help the interested decision-makers after Putting the qualitative results in front of them, planners', and farmers to evaluate their acceptance for adoption the suggestion methods and regulations, By increasing water efficiency through suitable agricultural investments and diverse species, and maximizing productivity based on investment suitability (plants, animals) to available water quantities.

To create water management policies, it is necessary to analyze the current state and conditions of water resources in WBG and propose strategic plans for active development. The present investigation entailed a comparative analysis of the plans that generated regulations and standards vis-a-vis the international and regional experiments. The findings were subsequently presented to the stakeholders for their assessment of the adaptability of the novel methods and innovations and their conformity with the extant norms and regulations. This study serves as a springboard for more focused research endeavors, encompassing a variety of techniques concomitant with water development and management policies, as well as in-depth inquiries

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aimed at augmenting the advantages of farmers and the agricultural sector. Furthermore, the study incorporated a comprehensive scrutiny of various extant studies.

Material and Methods

The principal modus operandi employed is predicated on the systematic analysis of secondary data, coupled with the comprehensive review of international (ICARDA) and national (NARC) experimental literature. The secondary data, gleaned from prior studies and various sources, are scrutinized meticulously to discern our strengths and weaknesses. This technique also serves to illuminate the trailblazers in the relevant domain, their methodologies, and innovative approaches to water management policies in dry areas. This methodology offers a potent instrument to unravel the intricacies and elucidate the salient aspects of the subject matter. In the interest of advancing water management practices and policies in arid regions, we have undertaken a thorough review of literature from both international and domestic sources, in addition to closely scrutinizing localized data from relevant institutions. By utilizing the SWOT technique to identify and evaluate our strengths, weaknesses, opportunities, and threats, we have gained vital insights into the optimal methods and innovations to foster the widespread adoption of these practices among farmers, institutions, and policymakers.

The territorial confines of historic Palestine are delineated by the frontiers of the West Bank and Gaza, while Israel has encroached upon the surrounding areas, as delineated in Figure 1. Regrettably, all subterranean aquifers and surface water resources, especially those situated in the north and along the Jordan River, remain under the dominion of Israel. This seemingly invidious situation is attributable to the inequitable water pacts between Palestine and Israel, such as the Oslo Agreement, which has resulted in our forfeiture of the right to regulate water resources.

Fig 1. Palestine general location map.

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Results and Discussion

Why Water is Limited

All resources, irrespective of their renewable or non-renewable nature, are limited to a greater or lesser extent. Non-renewable resources such as fuels and minerals are confined to the amount present on our planet, while water is considered a renewable resource. Water resources denote the sources of water that are useful or potentially useful for diverse activities, including agriculture, industry, household, recreation, and environmental activities (PCBS, 2019). Freshwater, which is a renewable resource dependent on annual precipitation, is crucial for most human uses. However, the world's groundwater supply is continuously declining, with the MENA region witnessing the most prominent depletion. The natural renewal rate of freshwater is uncertain, and it is unclear whether ecosystems are threatened by its usage. The framework for distributing water resources to water users, where applicable, is known as water rights (Mizyed, 2013). Dry areas across the globe are witnessing a continuous decline in water resources for agricultural purposes. It is estimated that irrigation accounts for a staggering 70% of the world's water usage, with 15-35% of irrigation withdrawals being deemed unsustainable. It is noteworthy that producing enough food to meet the daily dietary needs of a single individual demands a substantial amount of water, ranging from 2,000 to 3,000 liters, which is significantly higher compared to the mere 2-5 liters needed for drinking purposes (Haddad, 2010). To cater to the ever-increasing population of over 7 billion people on the planet today, the production of food requires a colossal amount of water - enough to fill a canal that is 10 meters deep, 100 meters wide, and stretches a staggering 2100 kilometers in length. Many countries in the world are living with chronic water scarcity in different percentages according to position and geological situation (Mizyed, 2013). Where the surface water is mostly tapped because of low precipitation in the driest areas, also ground is over-exploited, Climate change conditions rising last year adds to the problems that are causing high evaporation and leading to marginal quality, small amounts, not environment-friendly, and not healthy water (Abu-Zreig, 2000).

In dry areas, accessing renewable water resources can be a daunting task. Erratic rainfall patterns that vary in both space and time add to the uncertainty and risks associated with agricultural production (Oweis, 2010). The transitory fluctuations in the climate are anticipated to be exacerbated by the enduring climatic changes. The climate models indicate that the regions of West Asia and North Africa (WANA) will encounter intensified heat and aridity, along with modifications in the temporal and spatial patterns of precipitation, as well as a surge in the incidence and magnitude of severe weather phenomena such as droughts and floods. Nations situated in dry areas with primarily agrarian economies and a high reliance on agriculture will be the most susceptible to the adverse impacts of fluctuations in seasonal climatic patterns and alterations in contentious hydrological cycles. The paucity of freshwater resources in dry areas is a daunting challenge with numerous countries already falling below the "water poverty" benchmark of 500 m^3/capita/year.

Currently, a whopping 75% of the scarce water resources are earmarked for agricultural use. However, the burgeoning population and the escalating competition from the burgeoning industrial and domestic spheres are exacerbating the downward trend in the allocation of these

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resources (ICARDA, 2013). In many dry areas, governments are incessantly endeavoring to pioneer novel methodologies and approaches to mitigate the water scarcity crisis. Among these techniques is desalination, which is often deemed a costly and intricate solution. Another alternative is to import water from foreign countries, yet this can be impeded by exorbitant expenses and political impediments. The average annual water availability across various regions worldwide is elucidated in Figure 2.

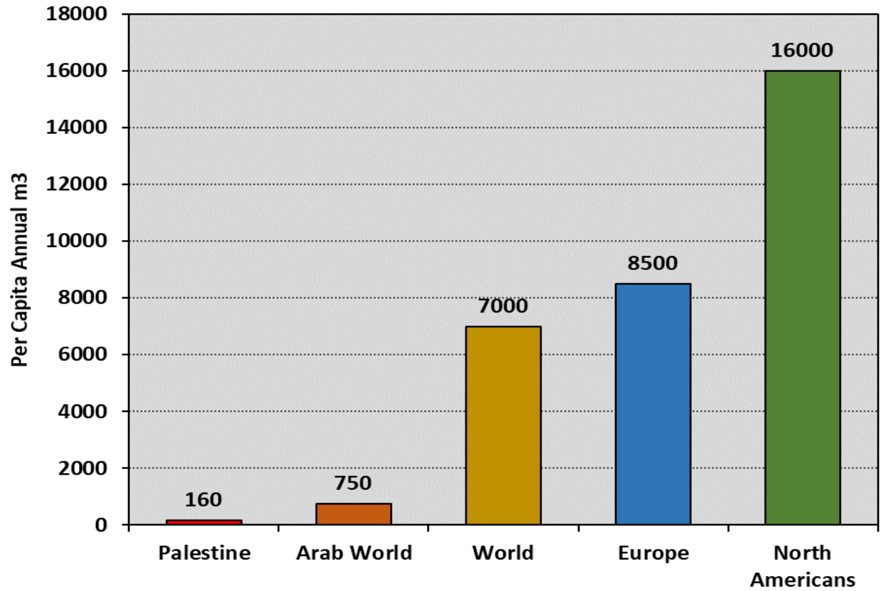

Fig 2. Average water annual among different regions/ per capita and Palestine.

The previous Figure 2 focuses on the average water/ per capita annual m^3 available, whereas we can note Palestine has very limited water quantities comparing other world on average, and compared with North America which represents the highest, which leads us to think about real solutions may leading and rising our share of water.

The graphical representation in Figure 3, elucidates the gradual reduction in the proportion of water accessible for agricultural purposes, which is attributed to the depletion of water resources and the deleterious effects of climate change. The foremost cause of this phenomenon is the conspicuous decrease in precipitation across dry areas. This, in turn, has a direct bearing on the portion of water resources allocated to the agricultural sector, which undergoes a diminishing trend as time elapses. As such, policymakers must devise efficacious strategies to counter this unfavorable trend.

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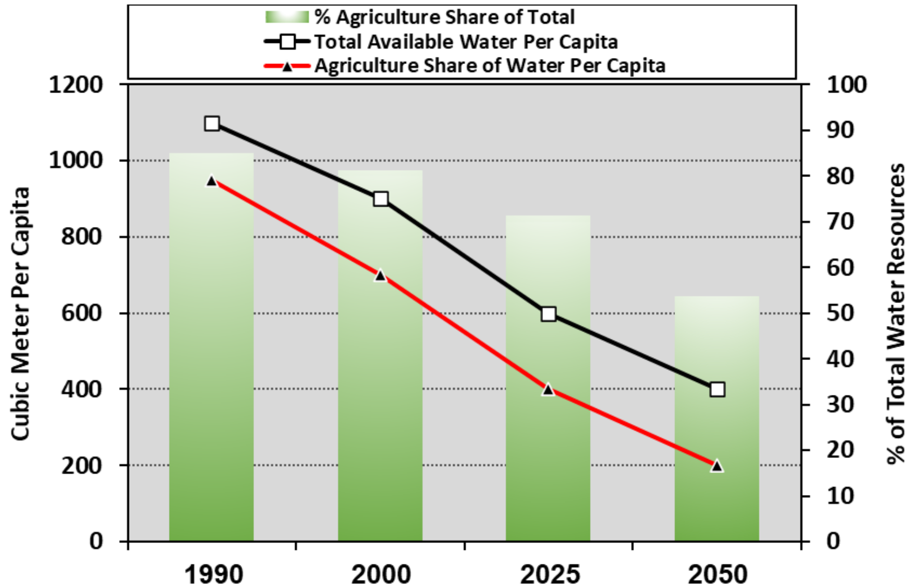

Fig 3. shows the percentage of water for agriculture in dry areas is declining.

Management with Less Water by Increasing Efficiency/Productivity

Globally, agriculture is the largest consumer of water resources, accounting for most of the water withdrawal in the MENA region, which is a staggering 85%. However, the utilization of water resources in agriculture remains highly inefficient, with only a minuscule portion of the water diverted for plant growth being effectively utilized. The remaining water is lost through drainage or evapotranspiration, as highlighted in a report published by ICARDA in 2011. As humanity multiplies and prosperity proliferates, the necessity for sustenance and consequently agricultural water for irrigation is burgeoning. Alas, the amount of water endowed with adequate quality is dwindling. Additionally, there is an escalating demand to shift a greater proportion of the water utilized in agriculture to higher-value urban and industrial uses. Hence, the only recourse is to augment productivity with reduced usage. Research has extensively examined water efficiency in agriculture for countless years. However, it is arduous to discover universally applicable solutions, particularly due to the assorted contexts and highly specified agricultural practices. Nevertheless, efficiency gains are frequently possible by selecting suitable crops, scheduling irrigation meticulously, implementing potent irrigation techniques, and utilizing alternative water sources for irrigation. It should be observed that enhancing water efficiency frequently yields benefits that extend well beyond diminished water consumption (Oweis, 2008).

Traditional Strategies

The traditional approaches to production Still control in most irrigated farming in Palestine where most farmers believe the production increases as water quantities increase, increasing production because of increasing water quantities considers the traditional thinking against

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productivity and may be useful when we have excess water, where water considering one of the main factors will affecting on productivity. Figure 4 shows the traditional effect on wheat productivity at one cubic meter of water is presented, one ton/hectare and 8 ton/hectare were produced from wheat seedlings whose height was 200 mm and 600 mm, respectively.

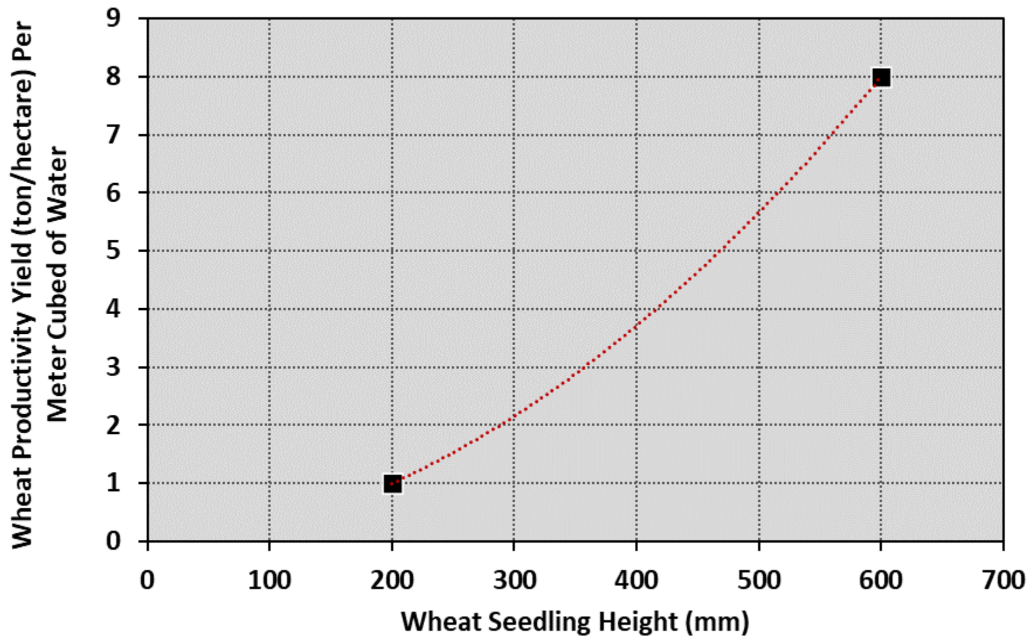

Fig 4. The traditional affecting about percentage of water in wheat productivity.

Integrated Management of Water and Land

Farmers toiling on the dry earth are plagued by water scarcity. At present, an array of factors, such as population expansion, land decay, and climate change-induced shifts, are compounding the woes of dry regions across the globe. These trends are heightening the uncertainty that rural, impoverished farmers face as they rely heavily on dwindling natural resources, which are rapidly degrading in the face of a changing climate. This time as a result of limited resources, Sustainable increases in future food supplies must come from increased productivity of both rainfed and irrigated crops, in addition to producing more crops per drop (ICARDA, 2010).

The present study endeavors to establish a nexus between research and policy in the domain of water and land management, with the overarching objective of enlarging the partnership base to encompass civil society and local research institutes. The study postulates that the focal point of research should be on appraising the quantity and quality of available water resources for agriculture, encompassing rainwater, surface water, groundwater, and marginal-quality water in dry areas. It is further recommended to evaluate the water and land productivity in agriculture at variegated levels, viz. plant, field, farm, domestic, and basin levels. Additionally, the study underscores the importance of assessing the active and efficient potential of using

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water-use efficient practices, and their concomitant effects on crop productivity, while simultaneously preserving the environment sustainably. Furthermore, the study accentuates the significance of considering the availability and potential use of marginal-quality water in agriculture in dry areas, and the environmental ramifications of its usage. Finally, the study advocates the development of multi-scale tools and methods to assess land uses and degradation, encompassing location, extent, causes, impacts, and consequences. To implement these recommendations, water benchmarks can be established in agriculture fields in Palestine through initiatives, such as the Water and Livelihood Initiative project, and the Irrigation Active Management for Improved Crops (ICARDA, 2011).

Increasing Efficiency of Water Usage

The primary objective of sustainable agriculture is to elevate agricultural production whilst efficaciously utilizing water resources and mitigating environmental degradation. To this end, a recent study enumerates a plethora of measures that farmers can undertake to augment their water efficiency and optimize farming operations across varying systems. These measures encompass bolstering irrigation system performance, ameliorating recoverable losses, enhancing irrigation system efficiencies, optimizing farm or crop use efficiencies, and scheduling agricultural irrigation based on evapotranspiration rates, soil moisture deficits, climate conditions, and exacting crop water requirements per diem. By judiciously accounting for these multifarious factors, farmers can quantify the economic impact of their irrigation practices to optimize their farming operations. Maximizing the use of water resources requires providing crops with the exact amount of water they need. Water use efficiency is the ability to achieve the desired outcome with minimal effort, time, expenses, and waste (Haddad, 2010). This is measured by the ratio of input energy to actual work output. Despite progress in water use efficiency, there is still ample room for improvement, particularly in increasing crop yield per unit of water and mitigating the risk of diffuse pollution from over-irrigation. Enhancing the agricultural irrigation system can help accomplish these objectives. Using a drip irrigation system is a smart way to increase irrigation efficiency compared to traditional methods like gravity systems, which flood entire fields and use shallow channels or ditches to deliver water to crops. If farmers choose to use pumping systems for irrigation, it's important to make sure that the pump and pipe size match their needs to prevent water and energy wastage, and subsequent leaks caused by over-irrigation. Evaluating infield irrigation performance involves assessing the irrigation matchmaking, a critical component of the process, as Pimentel et al. highlighted in their 2004 study.

There are several techniques that farmers can use to improve the efficiency of crop irrigation. These techniques can increase the yield per unit of water applied and reduce water loss due to various factors. Improvements can be made through smart design and management of water delivery and application schemes. Furthermore, decision support systems integrated with sensor networks can monitor soil and plant water status, helping farmers efficiently allocate limited water resources. These improvements can have a significant impact on the water use

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efficiency of crop irrigation. Irrigation efficiency is a way of measuring how efficiently water is used in irrigation within defined boundaries. Water use efficiency can be measured in various ways, some of which are traditional and widely used, while others aim to encompass the whole system and the temporal factors of efficiency. However, unlike productivity, which is measured in units, efficiency is expressed as a percentage. It is a measure of the net to gross water use or net days of irrigation for crops to gross days of irrigation used. (Basin Water Management, 2010)

Using Water Productivity to Facing Water Scarcity

A third of the world is currently facing water shortages due to the poor management of water resources and excessive water usage, particularly in agriculture. The International Water Management has reported that water scarcity is increasing faster than originally anticipated. Agriculture alone accounts for 80% of global water usage. Poor water management is causing billions of people worldwide to face water shortages. If water productivity is not improved, the consequences will be even greater water scarcity, according to Oweis (2010).

This section focuses on enhancing water productivity through water management interventions in the production of different crops such as lentils, potatoes, wheat, olives, dates, and beef. The evaluation is based on the amount of water used (1 m3) in production within experimental stations, regardless of the source of water, whether it is rain or irrigation. The ranking of water is based on Freed's assessment in 2009. Productivity is a measure of the economic or biophysical gain obtained from using a unit of irrigation water in crop production. It is expressed in productive units, such as kilograms per cubic meter or dollars per cubic meter and can also be used for livestock watering. This measurement represents the product obtained from the irrigated crop that the diverted water was intended for.

Measurement of Crop Yield per Unit Volume of Water Used in Agricultural Selection

Productivity is the correlation between the yield of a unit and the investment of a unit. Within this context, the term "water productivity" is exclusively employed to allude to the quantum or worth of agricultural produce over the extent or value of water exhausted or redirected for crop or alternative agricultural usage. The worth of the product might be communicated in diverse terms, such as biomass, grains, or currency. For example, the so-called "crop per drop" approach concentrates on the quantum of yield per unit of water utilized in agriculture. Another approach contemplated in this study is the differentiation in nutritional values for heterogeneous crops or the fact that the same quantum of one crop nourishes more individuals than the same amount of another crop with the same value of use. When engaging in discourse about food security, it is imperative to consider specific criteria (Renault and Wallender, 2000). Additionally, a significant aspect to consider is how to articulate the social benefits and effects of agricultural water productivity on livelihoods. There are various options posited for this purpose, including 'nutrient per drop', 'capita per drop', 'jobs per drop', and 'sustainable livelihoods per drop'. There isn't a singular definition of productivity, and the value assigned to the numerator ratio may depend on the focus and the availability of accurate information derived from field data. However, water productivity expressed as kilogram per drop is a lucid and efficient concept

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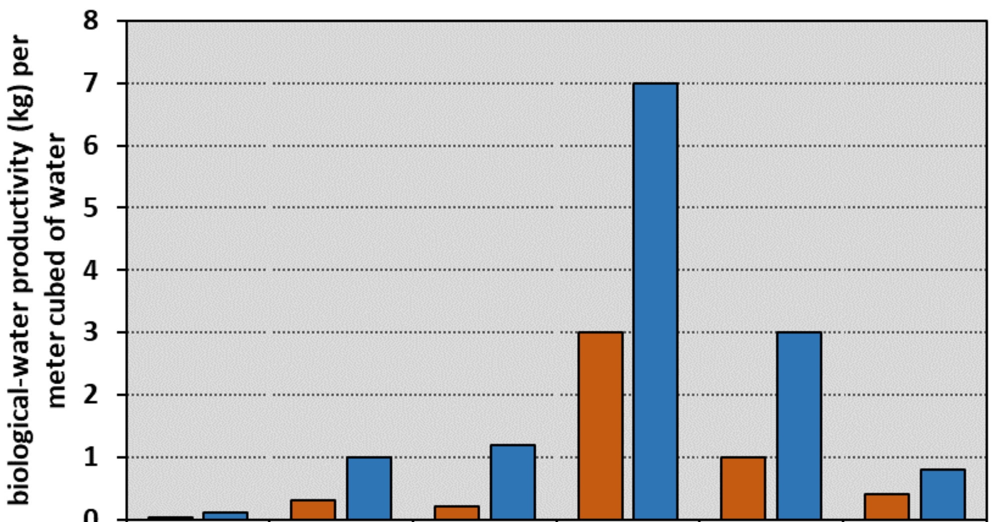
when comparing the productivity of water in diverse areas of the same system. Furthermore, it is a useful metric when assessing the productivity of water in agriculture with different cultivated crops (ICARDA, 2011).

Figure 5 below explains the calculated relationship between different crops (lentil, potato, wheat, olive, dates, and beef) and the consumption of one m3 of water in experimental conditions carried out at the ICARDA station. Upon scrutinizing the outcomes depicted in Figure 5, it was discerned that when farmers employ one m3 of water in the production of various crops, the weight productivity is pronouncedly greater in the cultivation of potatoes, followed by olives, and lastly, there is a low yield of weight from beef production. Ergo, if the production strategy is designed to enhance the weight productivity from each unit of water consumed, farmers should make a concerted effort to invest in potato and olive farming. By doing so, they can escalate the productivity of their produce and attain high production efficiency, considering all other pertinent factors.



	Beef	Lentil	Wheat	Potato	Olive	Dates
Exp.1	0.03	0.3	0.2	3	1	0.4
Exp.2	0.1	1	1.2	7	3	0.8

Fig 5. Biological-water productivity (kg) from one m³ used.

Revenue-Water Productivity ($) from One m³ Used in Selection Crops

Upon scrutinizing the findings illustrated in Figure 6, it was discerned that the utilization of one cubic meter of water to produce diverse crops can engender varying revenues. The cultivation of olive crops was found to yield the highest return, followed by date crops. Conversely, beef

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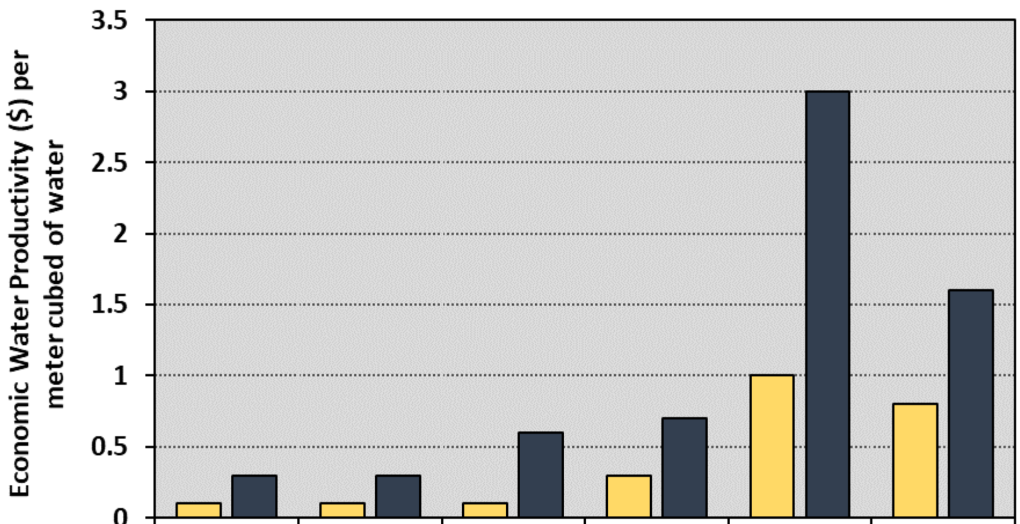
production resulted in a comparatively lower return on investment, albeit still superior to that of weight production, owing to the exorbitant price of meat. Ergo, if the objective is to augment revenue for each cubic meter of water consumed, farmers ought to contemplate undertaking the cultivation of olives and dates, contingent upon the suitability of other variables, such as temperature and labor. This can culminate in heightened productivity and efficiency in agricultural production.



	Beef	Lentil	Wheat	Potato	Olive	Dates
Exp.1	0.1	0.1	0.1	0.3	1	0.8
Exp.2	0.3	0.3	0.6	0.7	3	1.6

Fig 6. The revenue-water productivity in US dollars ($), per unit of water used (1 m^3).

Nutrition- Water Productivity from Protein, (gm) For One m^3 Used in Selection Crops

By analyzing the results shown in Figure 7 noticed that, when we use one m^3 of water in the production of different crops, founded that the highest nutrition revenue from protein by using one m^3 of water will be higher in wheat than lentil crops production, and low return revenue from protein from olive, dates, and beef production, where the wheat and lentil protein crops more than potato and olive, by the way, beef product mainly protein products as we noticed in the previous paragraph higher than the others, but the main reason for decline it's percent representing in calculation according one m^3 water unit where the beef production needs a lot of water according the production cycle. That means if our production strategy looking to increase the revenue form protein for every m^3 consumed, the suitable investment in wheat then lentil production, if the other production factors are constant where we can increase the productivity of protein from water unit, and leading to the high efficiency of production, after installing all the other factors.

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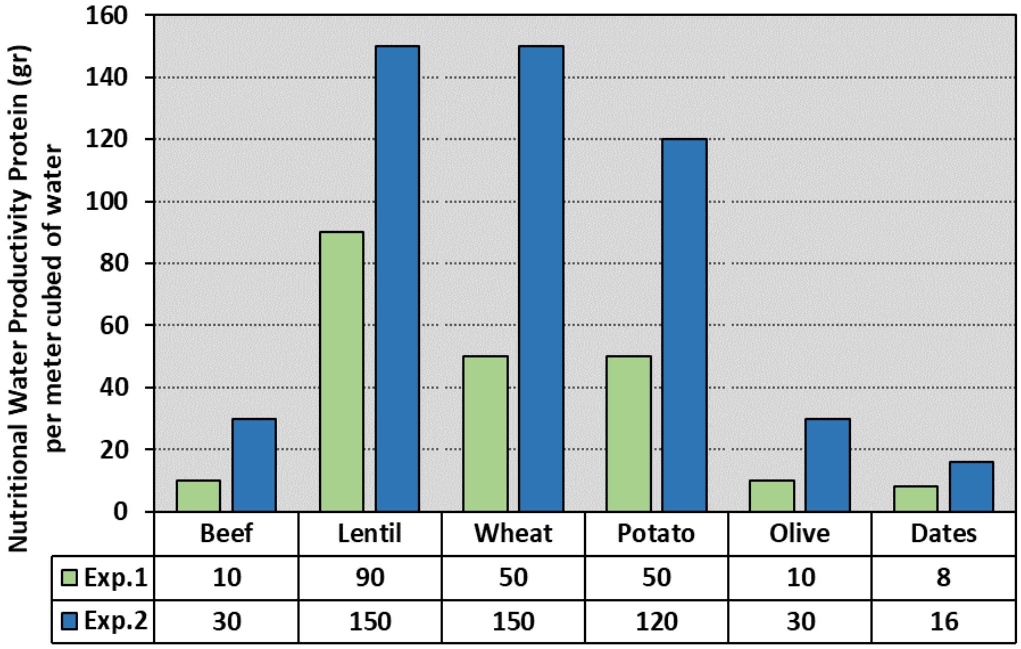

Fig 7. The nutrition-water productivity (protein) obtained from using one cubic meter of water.

Nutrition-water productivity from calories, (calories) for one m³ used in selection crops

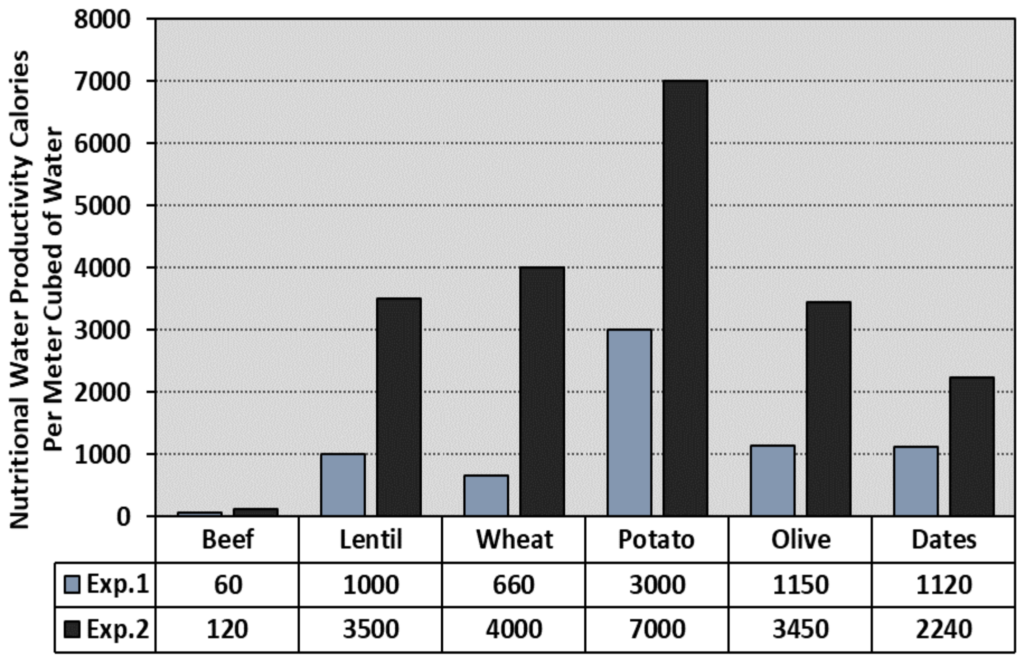

Fig 8. The amount of nutrition-water productivity (in calories) obtained from using one cubic meter (m^3) of water.

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Upon scrutinizing the findings depicted in Figure 8, it was discerned that the utilization of one cubic meter of water to produce diverse crops led to disparate nutritional outcomes. Notably, the optimal calorie revenue was attained from potato cultivation, which was followed by wheat, while beef production exhibited the most calorie returns per unit of water. This can be attributed to the fact that potato and wheat are high-calorie crops, whereas beef is primarily a protein-based commodity with a negligible calorie content. Ergo, if the aim is to maximize calorie revenue per cubic meter of water utilized, investing in potato and wheat production would be the most judicious decision. This would boost calorie productivity from each unit of water employed and, ceteris paribus, augment production efficiency.

Water harvesting (WHO) by developing rangelands (Badia)

Rainwater harvesting is a widely used technique in Palestine to collect and preserve precipitation, particularly in areas with large desert regions. This technique helps prevent rainwater from drifting away in deserts by using simple methods to create sustainable pastures. These methods involve developing contour lines in the desert, creating deep pits using large tractors, and planting seeds deeply. This leads to the collection of water around the seeds and the production of pastures for livestock using simple water harvesting techniques (ICARDA, 2011). In dry rangeland areas, where rainfall is limited and land degradation is a pressing concern, utilizing micro-catchment contour ridges and semicircular bunds for rainwater harvesting can be a game-changer. Not only does it allow for the effective use of scarce rainfall, but it also enhances productivity and helps to combat land degradation.

Fig 9. The integrated technologies used by the WHO for grazing management.

In Figure 9, we can observe the use of World Health Organization (WHO) methods in the Jordan desert. These methods aim to collect the vast advantages of rainwater by using simple

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techniques like drilling contour lines. The main goal is to assemble the largest amount of rainwater, prevent water flow, and maximize the collection of rainwater, which is scarce in these areas. These techniques have proven to be efficient in managing water and developing sustainable nature pastures. They have a high impact on animal production sustainability by making feed more available and affordable. This is crucial since feed prices are one of the main obstacles to animal production systems, as stated by Issa A. Gammoh and Theib Y. Oweis (2010). Rainwater harvesting is a sustainable practice utilized for the collection and storage of precipitation from various surfaces such as rooftops, land surfaces, road surfaces, greenhouse tops, or rock catchments. This technique involves the usage of rudimentary technologies like pots, tanks, and cisterns, as well as more intricate methods including underground check dams (Abu-Madi, 2009). The significance of this method stems from the fact that due to the sloping nature of West Bank lands, 90% of the groundwater is not under the control of Palestinians. Moreover, the water rights of the Palestinian people are restricted by several water agreements, resulting from the Oslo agreements. Israel maintains veto power over any new project or digging of new wells that may impact the water aquifers under occupation control (PCBS, 2019). The harvested rainwater is a renewable source of clean water that is ideal for domestic and landscape use in houses and some farms and can be implemented through several models (Abu-Zreig et al, 2000).

Water conservation systems offer adaptable and invaluable resolutions that can efficaciously cater to the exigencies of novel and extant sites, besides small and large farms dispersed in West Bank areas. Utilizing a water conservation system is a continuing process that can be optimized over time. The preponderant attraction of a rainwater harvesting system is the inexpensive cost, accessibility, and facile maintenance at the household and farmers' level (Abdulla and Al-Shareef, 2009). Owing to water paucity and limited supply, it is imperative to manage water resources effectually and maximize the utilization of every droplet of precipitation. As a result, water management projects are pivotal policies that policymakers need to enforce to hoard and utilize the utmost quantum of water in Palestine. Water harvesting techniques are widely prevalent in numerous parts of the globe, particularly in arid and semi-arid nations such as Jordan and African countries (Abu-Zreig et al, 2000). Precipitation runoff is augmented by collecting rainfall from designated zones and storing it in tanks and silos that are designed for human and animal consumption, in addition to supplementary irrigation in most agricultural crops (MOA, 2019). In 1983, the United Nations Environmental Program promulgated a report that enumerated diverse stratagems of amplifying the runoff from households and agricultural areas. Such stratagems included abluting inclined surfaces before use, mechanical treatment encompassing compacting the surface, contour terracing, and smoothing it to be congruous for planting sundry crops. Additionally, the deployment of chemicals to curtail infiltration and surface-binding materials to seal the surface was recommended, as well as covering the catchment area with a rigid or flexible surface for optimal control of water evaporation.

However, collating rainfall in tanks of differing sizes may prove exorbitant and might culminate in the squandering of voluminous amounts of water due to evaporation and defective mechanical connections (Abdulla and Al-Shareef, 2009). This is especially salient in arid and semi-arid regions where the quantity of evaporation exceeds the available quantity of rainfall by a substantial margin. To mitigate the issue of water evaporation, one plausible resolution is to employ enclosed storage tanks that are situated in a sheltered and fortified location. Although this solution can be rather effective in reducing water evaporation, the expenses can be exorbitant due to the utilization of perishable and costly materials. Alternatively, a feasible approach is to directly store accumulated rainfall in the soil for crop production and to implement a mono-cropping system by planting certain field crops between trees and mountain glades (Abdulla and Al-Shareef, 2009).

In sloped areas like the West Bank, the utilization of terraces, rippers, contour ridges, and micro-catchments is widely acknowledged to augment soil water storage and agricultural productivity. These techniques utilize the soil profile as a storage medium, thereby obviating the need for expensive storage tanks while minimizing water evaporation at a nominal cost, rendering them an economical solution (Lange et al., 2012).

Generally, in numerous parched and semi-dry locales, notably in Palestine, it is imperative to devise efficacious methodologies as part of water administration and national agrarian policies to enhance precipitation and ensure adequate water reservoirs for irrigation. Such measures are vital for the agricultural sector and contribute towards promoting sustainable agricultural development while preserving farm profitability.

Conclusion

The present study endeavors to conclude and characterize the extant scenario of water dearth in dry areas, particularly in Palestine (WBG), whilst factoring in distinct water usage conditions. The study asserts that an exigent requirement for more data and information, accurately portraying the diverse water management methodologies, is imperative. This is indispensable to competently assess the water status and formulate national water strategies that are better aligned with the aspirations of the Palestinians residing in (WBG).

The study's primary goal is to provide comprehensive guidelines for adapting agriculture to dry environments with scarce water resources. The study aims to achieve this by maximizing the available water quantities through managing water demands, using suitable agricultural investment, and increasing the efficiency and productivity of farm investment. The following are some of the guidelines the study recommends making this happen:

1. Land utilization and cropping patterns should be carefully evaluated to ensure that they are suitable for the available water quantities. By doing so, it will be possible to increase the efficiency of water usage.

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2. The study recommends providing specialized training and mentoring in irrigation. Additionally, sound institutional orientations should be considered when developing irrigation guidelines.

3. Allocating water to more water-efficient practices is another recommendation of the study.

4. The study recommends developing water-use-efficient germplasm by creating varieties that are resistant to drought and can adapt to the reality of water in dry areas.

5. Addressing socio-political issues related to water valuation is a crucial aspect of the study. This includes conducting socioeconomic research and raising public awareness. It is also important to start with the farmers' needs regarding crop patterns.

6. Utilizing marginal-quality water is another recommendation of the study.

7. Finally, the study recommends building new proactive policies to initiate change in our water situation.

As per the findings of this study, it is imperative to involve farmers in the decision-making process of water management projects right from the inception stage, alongside the political and technical aspects. It is crucial to impart training to them on a range of complex issues such as financial, environmental, legal, institutional, and economic aspects related to water utilization. Moreover, granting them the opportunity to participate in the development of standards would usher in sustainable and valuable water use efficiency, thereby expediting water management. This dissertation delves into diverse policies from disparate stakeholders to discern the causes of water restrictions. It presents plausible remedies for water demand management, sustainability, and curtailing the depletion of fresh water for irrigation purposes. The study advocates for expanding the utilization of water productivity and efficiency through investment and development of crops that are compatible with our production strategies (in terms of weight, monetary value, protein, and calories). These methods will promote the efficient allocation of water units, while also considering the socioeconomic aspects and raising public awareness about the benefits of these initiatives.

The predicament of Palestine is exacerbated by a dearth of potable water, consequent to regulatory measures implemented by Israel. To redress this issue, an alternative approach could be employed, namely, rainwater collection from the desert. Utilizing the technique of contour line drilling, the maximum quantity of rainwater can be amassed through silos and tanks, precluding the dissipation of the meager rainfall in these regions. These methods have demonstrated their efficacy in water resource management and the development of sustainable pasturelands. Although these technologies were ubiquitous throughout much of Palestine, their

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implementation was not widespread. By raising awareness of the social impact, potential, and performance of partial rainwater harvesting, families residing in small dwellings and engaged in agricultural pursuits may derive benefits from this practice.

There exist other ongoing investigations that pertain to the current political milieu. These inquiries are aimed at implementing active national policies to develop the agricultural sector as a crucial component of our national economic and sustainable strategy. The priority is to augment productivity from every unit of water utilized in diverse national strategic crops, which will ultimately result in an overall increase in water efficiency.

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