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Evaluation of Runoff Farming at Two Different Rainfall Zones of the Semiarid Climate of Erbil Province.

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Abstract

Rainfed agriculture in arid and semiarid regions is risky due to low rainfall and uneven distribution. To improve crop productivity runoff water can be utilized as alternative source of available water. Two field experiments were conducted at Chalook and Byok to study the interactive effect of five levels of catchment cultivation area ratio (0,1,2,3 and 4) and two catchment slopes (5% and 10%) on wheat growth and yield,15 runoff plots were established at each site and for each slope. Lower part of each plot served as a cultivated area, with dimensions of 2.5 m x 3 m and kept nearly flat. Conversely the upper part of each plot served as scarified catchment, all of the same width of 2.5 m, but of different lengths to offer catchment cultivated area ratios of 0,1,2,3, and 4. Results showed a gradual increase in wheat grain yield and aboveground biomass with an increase in catchment to cultivated area ratio (CA:C) at both sites. However, the catchment slope produced a higher grain yield compared to 10% slope, but the difference was insignificant. The theoretical CA:C values compared to the maximum applied ratio suggest the possibility of further increase in grain yield with an increase beyond 4:1, particularly at Chalook site. Byok site outperformed the Chalook site due to increased water arability at the former site. Linear regression analysis revealed that CA:C merged as the most effecting factor affecting grain yield, followed by annual rainfall. Over 91% of variation in grain yield can be assigned to variations in CA:C, annual rainfall, and catchment slope.

Keywords: Water Harvesting, Design Rainfall, Runoff Farming, Catchment Cultivated Area Ratio, Grain Yield Modelling,

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1.Introduction

In arid and semi-arid regions, the primary obstacle to the growth of agriculture and the improvement of rangelands is a lack of water. As a result, techniques for harvesting water have been employed for a long time to increase the amount of water stored in the soil and decrease erosion (1). In areas having the problem of water shortage, rainwater harvesting is a proxy to mitigate the bad consequences of water scarcity life (2).

Water harvesting refers to the practice of collecting and storing rainwater runoff from a larger catchment area for use in a smaller, targeted location (3). There are two primary types of water harvesting systems: direct systems, which store runoff water in the soil, and storage systems, which use tanks or pools to collect and store runoff water. The later system resembles a form of irrigation in that the collected water is diverted to the planting areas (4). Water harvesting techniques are made up of two parts: the area where runoff is gathered, known as the catchment area, and the area where the runoff is directed and used, known as the cultivated area (5). A microcatchment system is a form of water harvesting that involves collecting runoff from a small area and directing it to a nearby agricultural area. The collected runoff is then either stored in the root zone for direct use by plants or stored in a small pond for future use (6). The length of flow is usually less than 100 m (7).

To meet the plant water requirement during runoff farming, there is an urgent need for scarifying catchment area estimation. The area along with the cultivated area can be used for calculating the CA:C ratio (8). The catchment cultivated area ratio is a key parameter in the design of microcatchment water harvesting technique. This ratio ranges between 1 and 10. There is a lack of a database on the optimum value for this ratio for various farming systems (9). On the other hand, Ojasvi, Goyal (4) reported that the ratio runoff area to cultivated area can range from 1:1 to 20:1

The majority of the agricultural lands in the Iraqi Kurdistan Region is under rainfed agriculture, particularly, the areas situated in the southern part of this region. In this part the annual rainfall is inadequate and irrigation water is insufficient. Albeit regions with high rainfall can meet the crops demand, the spatial and temporal variations of rainfall in such regions make rainfed agriculture risky. Under this situation, rainwater harvesting meets the water demand of crops, but sometimes its spatial and temporal distribution make rainfed farming a risky proposition. Water harvesting can lessen the risk of failure through making early cropping possible and taking benefits from rainwater during drought periods. This implies that water harvesting ensures the growing crops against rainfall aberrations however, the amount of water stored, storage efficiency, and improving water use efficiency are other important factors that affect rainwater harvesting (10).

The microcatchments are one of the common forms of direct rainwater harvesting systems and their use is traced back to the nineteenth century for watering olive plantations in Tunisia (11). Microcatchment systems have a lot of advantages over other irrigation methods in that they are low-cost to construct and can be implemented quickly using indigenous materials and local manpower (12).

The design of runoff strips is based on several factors, namely the type and depth of soil, land topography and the ratio of catchment to cultivated area. The ratio analysis requires crop water requirement data, design rainfall, runoff coefficient and the efficiency factor (8). Renner and Frasier (13) reported that for a successful microcatchment system, the catchment needs to be flat and have a sufficient slope to produce runoff during storm occurrences. Additionally, the soil in the cultivated area needs to be deep enough and have a suitable texture to allow for infiltration and water storage.

This study was started with the following aim in mind because there aren't many studies evaluating the impact of runoff farming methods on increasing agricultural production in the region under study:

to calculate the impact of catchment slope and the ratio of catchment area to farmed area on wheat growth and production.

To determine the effect of ratio of catchment area and cultivated area on soil moisture conservation over the growing season. To build up a model to predict crop yield from some selected input variables.

2. Materials and Methods

2.1. Sites Description

The current study was carried out at two sites representing two rainfall zones. The first site is about 9 km to the east of Khabat county (Latitude = 36º 36′ 25″, longitude= 44º 28′ 13″ and altitude = 435 m amsl), while the second site is located to the northeast of Bardarash and about 18 km from the center of the district (Latitude = 36º 56′ 25″, longitude= 44º 27′ 32″ and altitude = 352m amsl) (Fig.1). The soil texture of the surface layer is silty clay for both Chalook and Byok sites. The average annual rainfall at these two sites is 321 and 419 mm respectively.

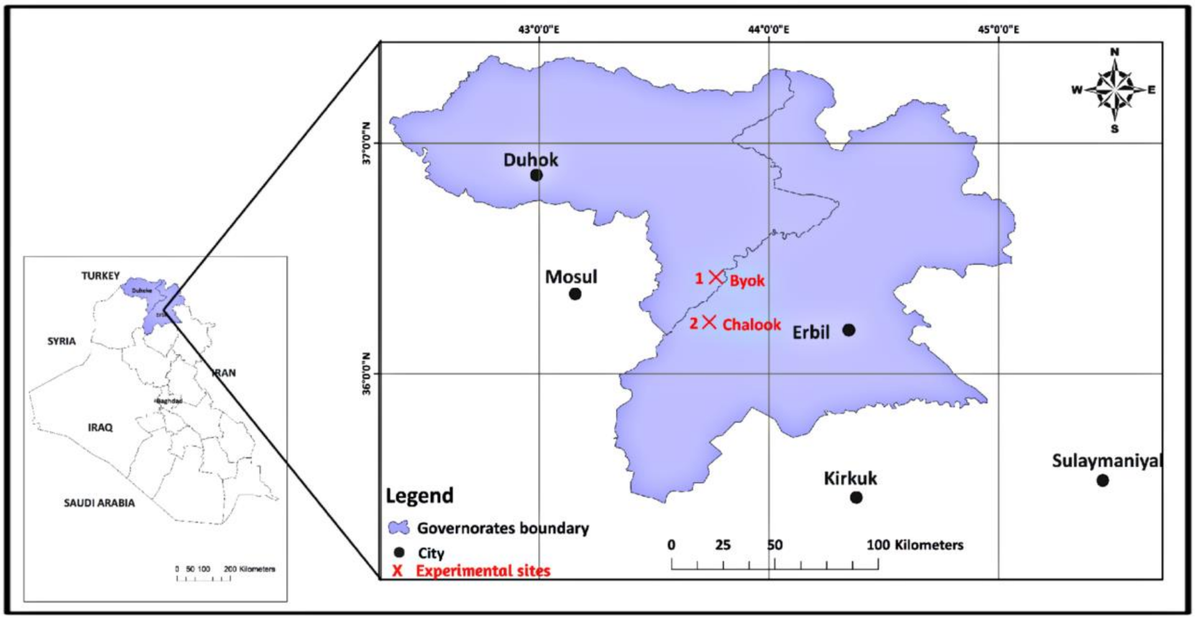


Figure 1: The location map for the experimental sites.

2.2. Land Preparation

Initially, two subareas were selected at each site having slopes of 5% and 10%. Before delineating the experiment layout, a rough grading was performed for the catchment area located to the upstream of the cultivated area with a minimum disturbance through removing abnormalities and filling minor depressions and removal of plant residues. To effectively increase the runoff efficiency, The soil of the catchment was also cleared from large stones, graded, smoothed, and compacted with a spade.

Regarding the cultivated area, it was flooded with water and allowed to soak in. After several days when the soil became plowable, the cultivated area was hand plowed to a depth of 20 cm, clods were disked, and the soil surface was left nearly flat prior to seeding. A ditch was also constructed to divert the upstream flows away from the experimental plots. Additionally, a runoff plot was established at each site and its description was demonstrated in section 2.5.

2.3. Experimental Layout

Following land preparation, a total of 15 runoff plots were established for each slope at each site in the form of three blocks. The plots were separated from each other by a distance of 0.5m, while the blocks were separated from each other by a distance of 1 m. The lower part of each plot served as a cultivated area, with dimensions of 2.5 m x 3 m and kept nearly flat. Conversely, the upper part of each plot served as scarified catchment, all of the same width of 2.5 m, but of different lengths of 0, 3, 6, 9 and 12 m to offer catchment cultivated area ratios of 0, 1, 2, 3, and 4. Each plot was isolated by earth bunds 30 cm in height. Fig.2 exhibits the layout of the runoff farming.

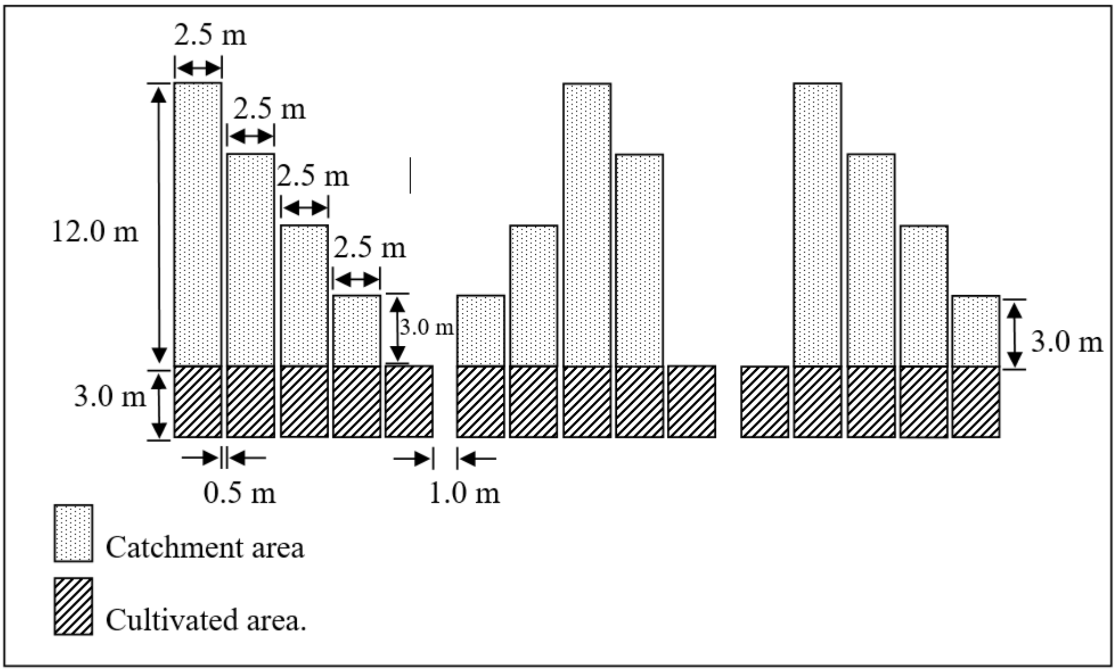


Figure 2: Layout of the runoff farming at the investigated sites.

2.4. Intercultural Operation

The wheat cultivar (Hawler 2) was seeded on 15 November 2022 at both sites at a seeding rate of 120 kg/ha in the form of rows set 20 cm apart. The weeds were controlled by using Paraquat herbicide at a rate of 2L ha-1 after 50 days from planting. The crop was fertilized with NPK fertilizer and (DAP) at a rate of 80 kg ha-1 at the sowing time. Nitrogen was also applied in the form of urea in two doses. The first dose of N was applied at the time of sowing at a rate of 60 kg ha-1, while the second dose of N was applied at the same rate of 60 kg ha- 1, but after 2.5 months from sowing. After 50 days from planting. Additionally, weeds were controlled manually as needed over the growing season.
All plants within each plot were hand harvested for determination of the total yield and grain yield and yield components during the second week of June 2023.

2.5. Insitu Measurement of Runoff Coefficient.

To measure the runoff coefficient, a runoff plot with dimensions of 2.5 m x 6.5 m was established at each site close to the experimental plots, the longer length following the direction of the land slope. Earthen ridges were built around the plot with a height of about 30 cm above ground and compacted to stop water flowing from outside into the plot and vice versa. In order to facilitate a smooth flow of runoff water from the plot into a barrel with a capacity of 220 liters through a plastic pipe 10 cm in diameter, the soil at the bottom edge of the plot was cemented to form an apron. The barrel was covered to protect the content against evaporation and rainfall. After each rainfall event, Through the use of a calibration curve between height and volume of runoff in the tanks, the height of the water in the tank was measured and converted to liters. The catchment was equipped with a non-recording rain gauge.

2.6. Crop Evapotranspiration

The potential evapotranspiration was estimated based on the formula suggested by Penman-Monteith as outlined by Allen, Pereira (14):

$$ET_p = \frac{0.408\Delta(R_n - G) + \gamma U_2 (e_s - e_a)\frac{900}{T+273}}{\Delta + \gamma(1 + 0.34U_2)} \quad .....[1]$$

where ETp= the potential evapotranspiration (mm day-1), Δ: the slope of vapor pressure against temperature plot (kPa °C−1), Rn: net radiation (MJ m−2 day−1), G: heat flux density into and out of the soil (MJ m−2 day−1), γ: psychrometric constant (kPa °C−1), U2: wind speed at a height of 2 m above ground [m s−1], es and ea denote actual and saturation vapor pressure (kPa),

respectively (kPa), T: the average daily air temperature at a height of 2 m (°C), The CROPWAT version 8 software was used for performing the calculation of ETo according to the above equation.
The monthly potential evapotranspiration for each month during the growing season was multiplied by the crop coefficient of wheat at that month to determine the crop evapotranspiration or:

$ETci = Kci\ EToi$ ……………………….[2]

Where:
ETci = crop evapotranspiration for the ith month
Kci= Crop coefficient ff wheat for the month i
The seasonal crop evapotranspiration was obtained by summing up the monthly crop evapotranspiration during the growing season.

2.7. Design Rainfall

The annual rainfall recorded at Khabat and Bardarash with a time span from 1998 to 2021 was obtained from the Ministry of Agriculture and Water Resources. these stations were the closest stations to the experimental sites. The obtained data were ranked in descending order (with the highest value at m=1 and the lowest value at m=24). The following plotting position expression was used for calculating the probability of occurrence of each event (15):

$$\frac{1}{T} = P = \frac{m - 0.375}{N + 0.25} x100 \quad \text{………………[3]}$$

where
T = indicates the return period (in years).
P= The probability of an event with a rank of m occurring.
m= Rank of the arranged events when arranged in descending order
N= Number of observations
Afterwards, the ranked observations were plotted versus the probability of occurrence on a probability paper. Finally, the best curve was fitted to the plotted points with the main objective of design rainfall determination which corresponds to a probability of 67%.

2.8 Factor Efficiency

Efficiency factor can be defined as the efficiency of runoff water utilized by the grown crop. A considerable portion of the harvested runoff water is lost via evaporation and deep percolation below the root zone. The value of this parameter varies from a minimum of 0.5 to a maximum of 0.75 depending on several factors (8). On average, the value of this factor is 0.625 (16).

2.9. Catchment: cultivated area ratio (CA/C)

The catchment cultivated area ration was calculated using:

WH =WD ………………………………[4]

WH = Volume of water harvested from the catchment area (L)
WD= volume of water deficiency or extra water needed in the planted area (L)

WH= CA (DR x Rc x EF) ………..…….[5]

WD= C (CWR – DR) …………………[6]

Where CA is the catchment area (m^2), DR is the design rainfall (mm), Rc is the runoff coefficient (-), EF is the efficiency factor (-), C is the cultivated area (m^2), and CWR is the crop water requirement (mm).
We obtain by replacing the formulas for WH and WD in Eq [1].

CA (DR x C x EF) = C (CWR – DR) .. [7]

By dividing both sides of Eq. [4] by C and arranging, the following expression for CA:C can be obtained:

$$\frac{CA}{C} = \frac{\text{CWR - DR}}{\text{DR x Rc x EF}} \quad \text{…………………...[8]}$$

2.10. Soil moisture monitoring

The soil moisture content of the cultivated area was monitored periodically during the growing season to a depth of 60 cm at equal increments of 20 cm (i.e., three layers) using a small auger. The average soil moisture content of each layer for the three replications was computed. The overall soil moisture content of the soil profile(d) was computed according to:

$$di = \frac{\sum_{i=1}^{n} w_i z_i}{\sum_{i=1}^{n} z_i} \quad \text{............................[9]}$$

where wi = the average soil water content of the ith layer (kg kg-1); and zi = the thickness of the ith layer (mm).

2.11. Methods of Soil Analysis

The soil water content was measured gravimetrically according to the procedure outlined by (17). The particle size distribution was carried out using both hydrometer and sieve methods, as reported by (17). The bulk density of the soil was determined using the core method, as described by (18). The soil organic carbon was quantified using the Walkley-Black wet oxidation method (19). The pH of the saturated extract was determined using a pH-meter model Hanna pH211 in accordance with (20). The EC of the saturated extract was determined using an EC in accordance with (20)

3. Results and Discussion

3.1. Effect of Ratio of Catchment to Cultivated Area on Growth and Yield of Wheat

3.1.1. Plant Height

Figure 3 depicts the effect of catchment to cultivated area ratio and catchment slope on wheat plant height at the two studied sites, namely Chalook and Byok. As can be seen in Fig.3 at both sites the plant height varied from a minimum of 44.15 cm under control treatment with a 10% slope at Chalook site to 67.03 cm for the treatment with a ratio of 4:1 and 5% slope at Byoke site. There is also a progressive increase in plant height with an increase in the catchment to cultivated area ratio for both slopes (5% and 10%) at the two investigated sites. In a similar study, Safi (21) observed that the gentle slope yielded higher biomass than the steep slope under contour ridge treatment. Compared to Chalook site, the Byok site offered a higher plant height under the same treatment combination. One plausible explanation for this difference can be attributed to higher water availability and more climatic condition favorable at Byok site. The collected data show that soil moisture is a limiting factor for crop yield in the study area.

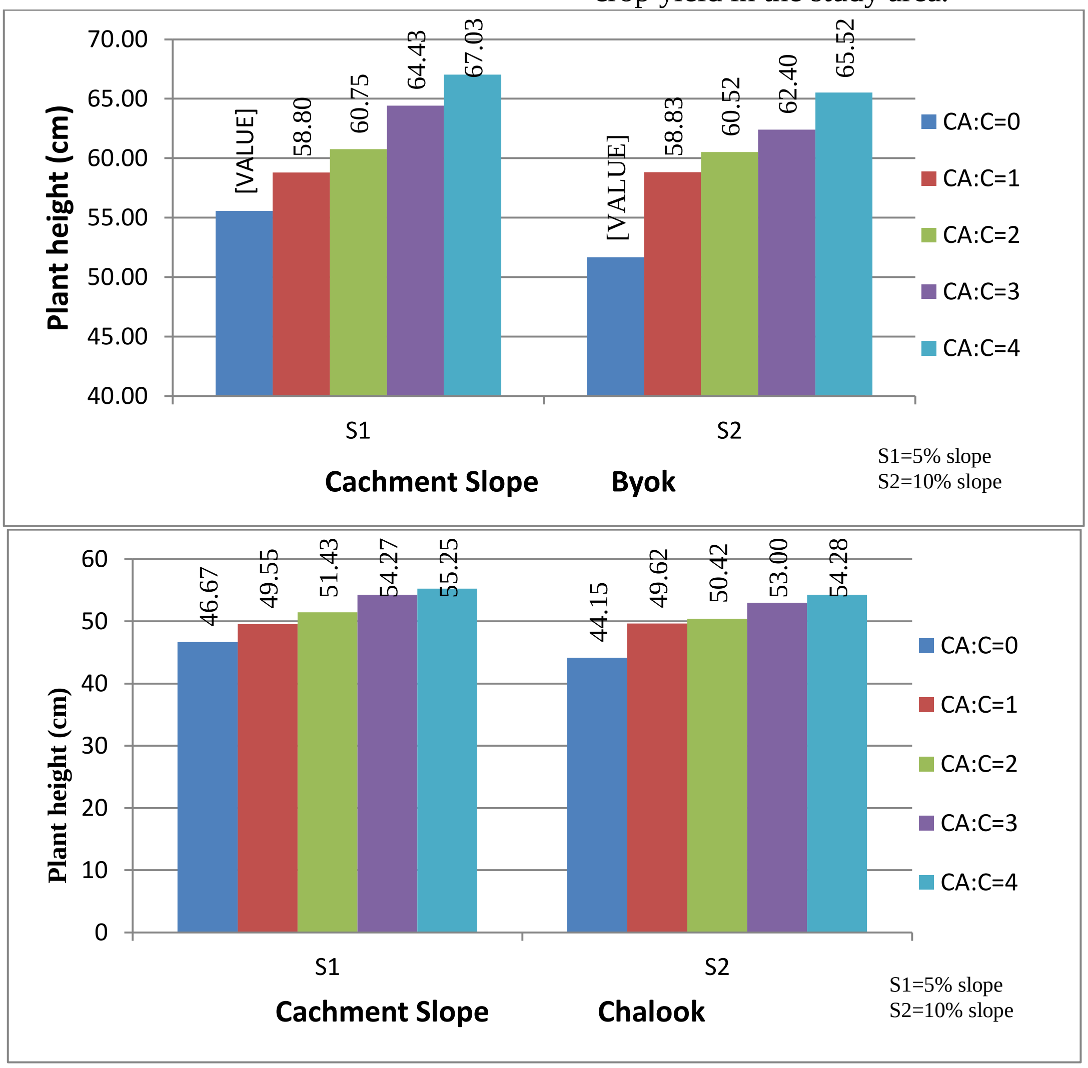
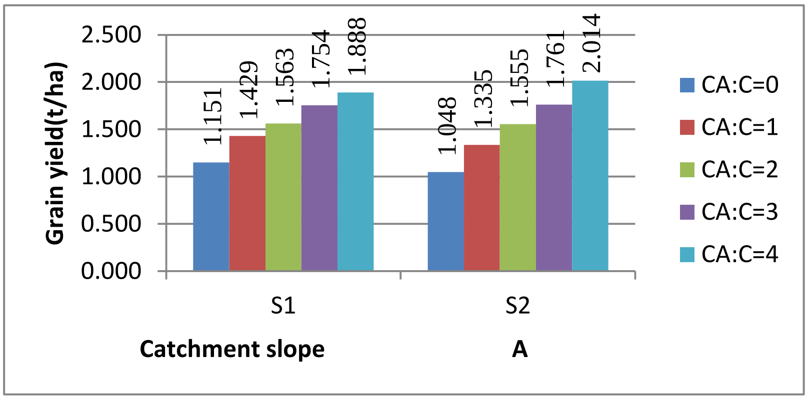


Figure (3): The effect of catchment-to-cultivated-area ratio and catchment slope on plant height at the studied sites.

3.1.2. Grain Yield and Aboveground Biomass

The results shown in Fig. 4 demonstrate the effect of catchment to cultivated area ratio and catchment slope on the yield of grains and above-ground biomass (total yield) of wheat at Chalook site. Like plant height, both grain and total yields were substantially affected by ratio of catchment to cultivated area. At this site, the lowest grain yield (1.048 t/ha) and total yield (3.1 t/ha) were achieved under the control treatment with a 10% slope, whilst the maximum value for the grain yield was achieved with a ratio of 4:1 under a 10% slope. The maximum value for the aboveground biomass was about 4.5 t/ha.



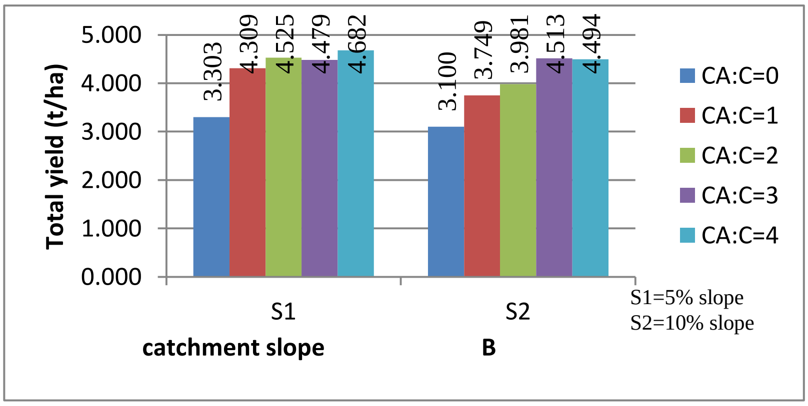


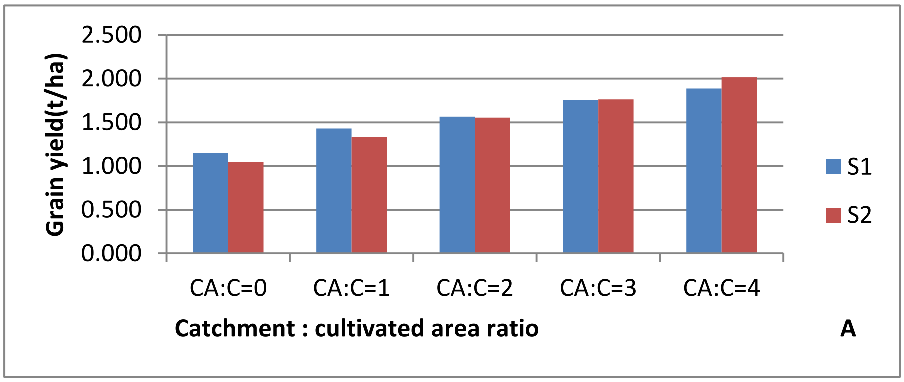
Figure (4): Effect of catchment-to-cultivated-area ratio and catchment slope on grain yield and total yield at the Chalook site.

Close inspection of the data revealed that with two exceptions, there is a steady increase in grain yield and the aboveground biomass with an increase in the ratio of catchment to cultivated area. This can be explained by increasing the ratio of runon to runoff area from 0 to 4 and so increasing water availability. This result supports the finding of FRASIER and Schreiber (22), who observed greater yield under a ratio of 2:1 compared to that under the control treatment.

The data of Fig.4 also showed that the ratio of catchment to cultivated area of 1:1, 2:1, 3:1 and 4:1 increased the grain yield by 24.17%, 35.80%, 52.42% and 64.07% respectively compared to the control treatment over a slope of 5% and by 27.43%, 48.35%, 68.08%, and 90.20% over the slope of 10% at Chalook site.

No substantial differences in both grain yield and the aboveground biomass can be depicted under a given ratio of catchment to cultivated area for the catchment slopes. Overall, the grain yield and the aboveground biomass under the same ratio of catchment to cultivated area over a slope of 5% was slightly superior to those under 10% (Fig.5). The Dunnett t-test revealed that the ratio of catchment to cultivated area differed significantly from the control treatment at level of significance of 5%.

S1=5% slope
S2=10% slope



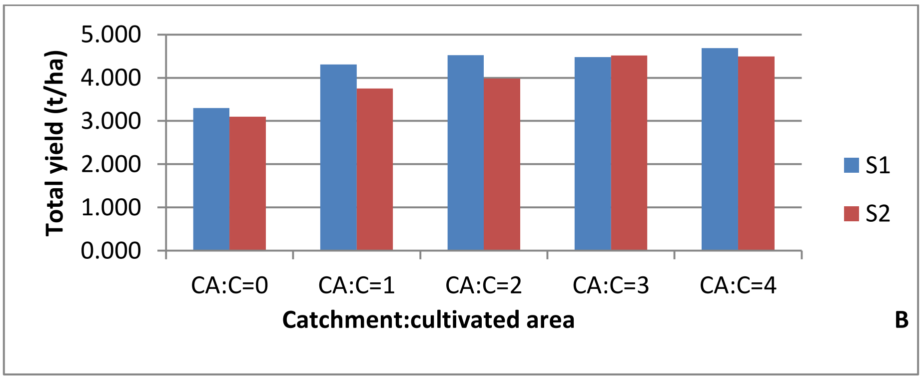


Figure (5): Replotting the effect of catchment: cultivated area ratio and catchment slope on: A) grain yield and B) Total yield at Chalook site.

Comparison of grain yield with the aboveground biomass under the same treatment combination revealed that they are in harmony with each other, i.e., the grain yield was on par with the above ground biomass. For instance, the control treatment exhibited the lowest value for grain yield and the aboveground biomass over the same slope. Conversely, the ratio of 4:1 offered the highest value for these two parameters over the same slope.

Similarly, in the Byok site, there is a gradual rise in grain yield and aboveground biomass as the CA: C ratio increases from 0:1 to 4:1 (Fig.6). The treatment combinations at this site offered a higher performance compared to those at Chalook site. As mentioned earlier, the higher annual rate at Byok site is responsible for superiority of both grain yield and aboveground biomass at this site to those at the Chalook site. At this site. the ratio of catchment to cultivated area of 1:1, 2:1, 3:1 and 4:1 increased the grain yield by 36.67%, 68.25%, 105.91% and 130.10% respectively compared to the control treatment over a slope of 5% and by 66.89%, 66.40%, 97.69%, and 131.58% over the slope of 10% at Chalook site.

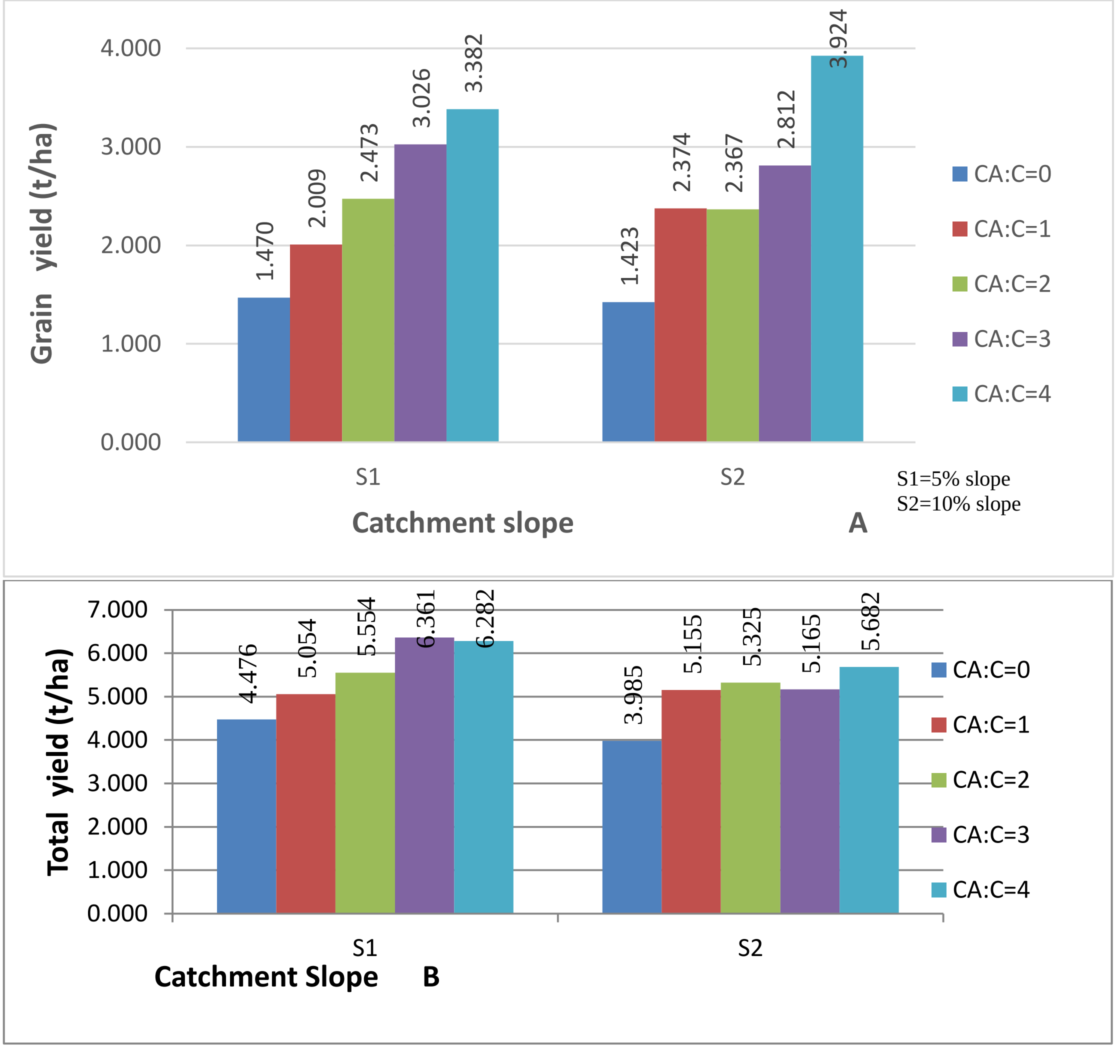


Figure (6): Effect of ratio of catchment to cultivated area and catchment slope on: A) grain yield and B) Total yield at Byok site.

As with the Chalook site, no substantial changes in grain yield and aboveground biomass were detected due to changes in catchment slope. These two parameters tended to decrease slightly due to an increase in slope from 5% to 10%(Fig.7). The lower yield over slopes greater than 5% may be attributed to uneven distribution of runoff water. Additionally, the need for larger quantitative of earthworks over steep slopes makes water harvesting impractical from an economic point of view(23). In the view of the authors, the Chalook site is in need of a higher ratio. The catchment to field ratio of 4;1 and 3:1 is economic at Chalook and Byok respectively. The greater an area's aridity, the larger the required catchment area in ratio to cropping area for the given water output (24).Two–way AVOVA analysis revealed that all the response variables(plant height, aboveground biomass and grain yield), were affected significantly ($P \le 0.05$) by ratio of catchment to cultivated area at both sites, while only aboveground biomass was affected by catchment slope. In contrast, none of the response variables were affected by the interaction between the ratio of catchment to cultivated area and catchment slope. However, Dunnett 's test also indicated the difference between the grain yield at CA: C ratio of 1, 2, 3 and 4 and that at control were larger than the Dunnett's D of 0.152 and 0.318 at Chalook and Byok sites respectively.

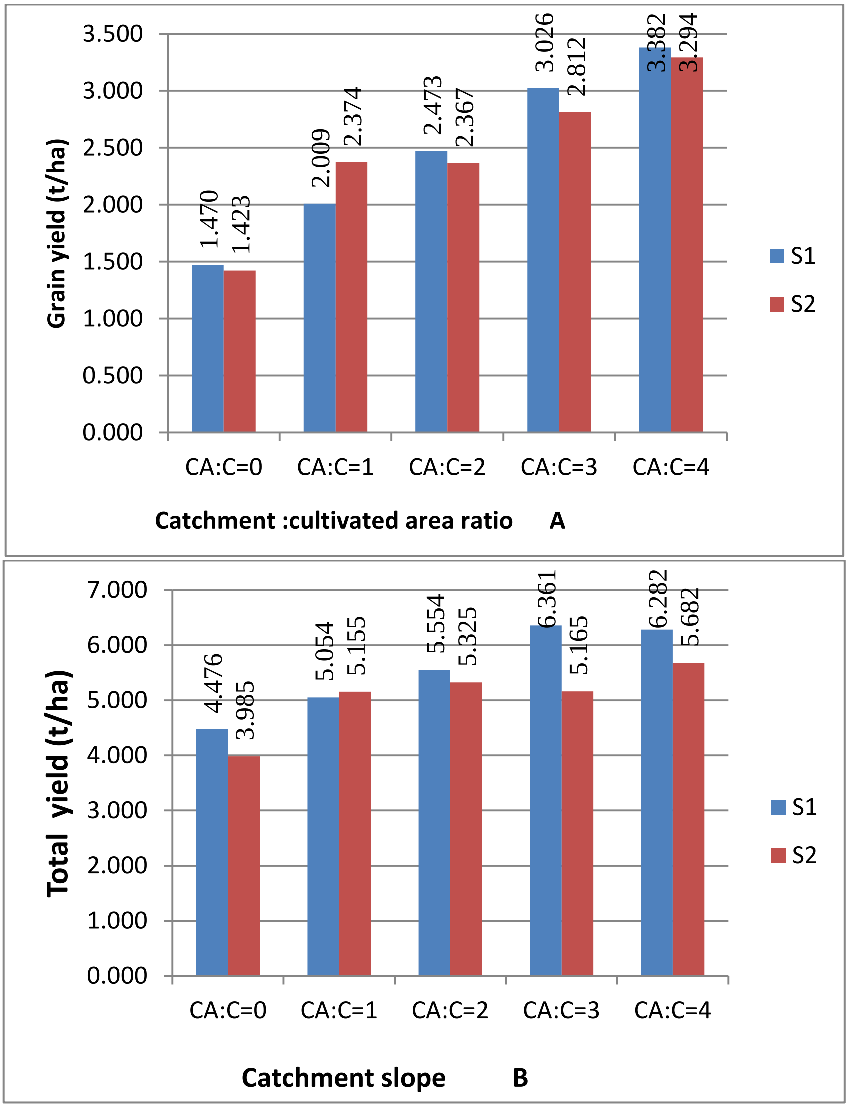


Figure (7): Replotting the effect of catchment: cultivated area ratio and catchment slope on: A) grain yield and B) Total yield at Byok site.

3.2. Water Content of the Soil Profile

Fig. 8 portrays the effect of the ratio of catchment to cultivated area and catchment slope on the average soil moisture content of soil profile up to a depth of 60 cm at Chalook site. To compare the effect of slope on this parameter the data of Fig 8 was replotted and displayed in Fig.9. Each data point represents the average water content of three depths (0.0-0. 2 m, 0.2 -0.4 m and 0.4-0.6 m) obtained at five dates over the growing season (3/2, 28/3, 2/4, 13/4 and 17/4/2023). As with the previous study parameters, there is a continuous increase in the average soil profile water content with an increase in the ratio of the catchment to cultivated area. It ranged from 20.87% under control treatment to 24.05% under the ratio of 4 when the catchment slope was 5%. Similarly, it ranged from 18.98% under control treatment to 23.16% under the ratio of 4 when the catchment slope was 10% this result was expected because the higher ratio led to higher runoff volume. This finding is in concordance with the findings of Keya (25) who noticed the volumetric water content gradually increases as the catchment to cultivated area ratio increases from 0.5:1 to 2:1. Further, upon replotting the data of Fig.8 as shown in Fig.9, the results indicated that the 5% slope was superior to the 10% slope. The ANOVA-test disclosed that there is no significant difference between the two levels of catchment slope.

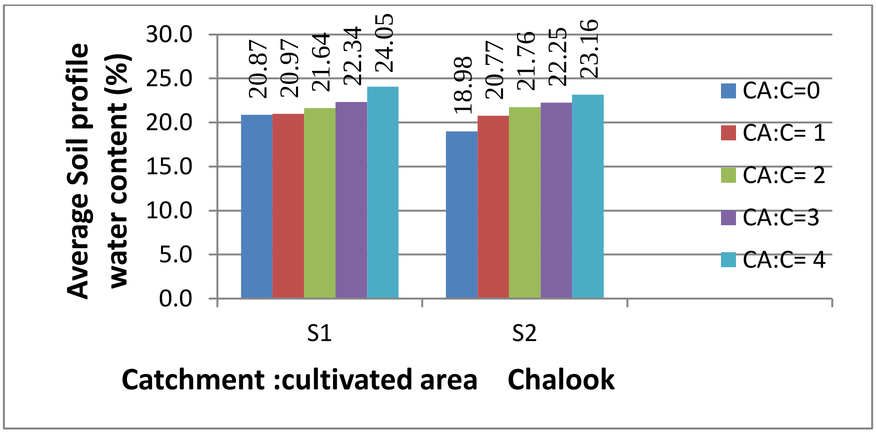


Figure (8): Effect of the ratio of catchment to cultivated area and catchment slope on average soil profile water content at Chalook site.

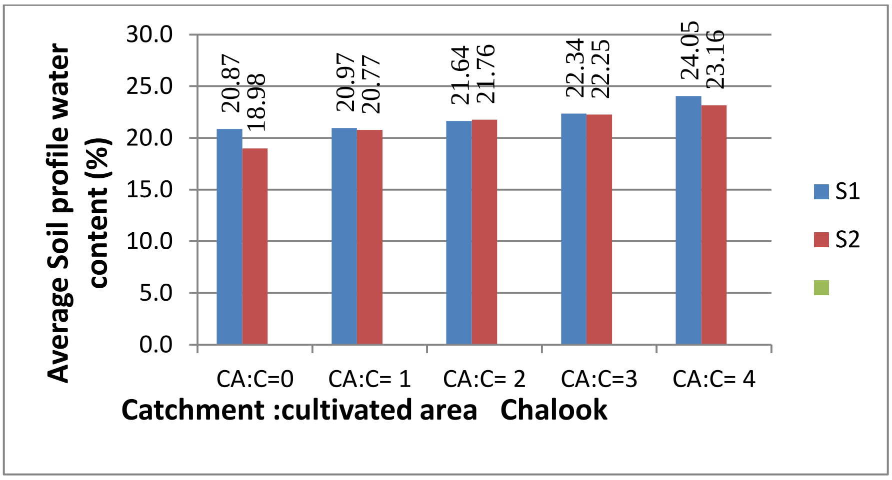


Figure (9): Replotting the effect of the ratio of catchment to cultivated area and catchment slope on average soil profile water content at Chalook site.

It is interesting to note that the same procedure was followed to monitor the soil profile water content at Byok site, and the results are displayed in Figs. 10 and 11. Overall, the soil profile water content tended to increase with the increase in the ratio of the donor to the collector area with some deviations under a 10% slope. Moreover, the catchment slope did not have an obvious effect on the average soil profile water content at this site. The interference from the vigorous growth of the growing plants or higher water consumption at this site may be responsible for dissimilarity in trends.

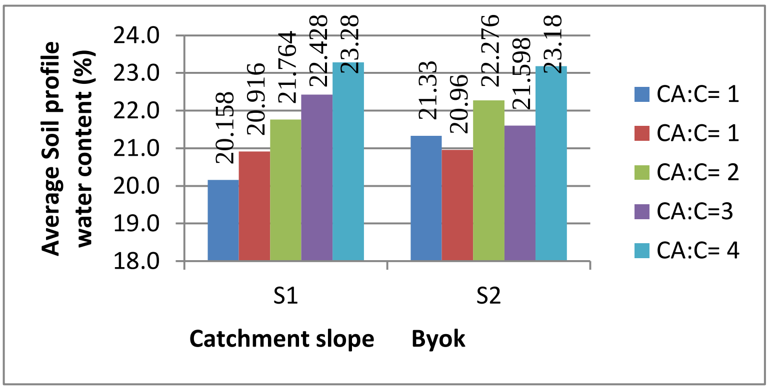


Figure (10): Effect of the ratio of catchment to cultivated area and catchment slope on average soil profile water content at Byok site.

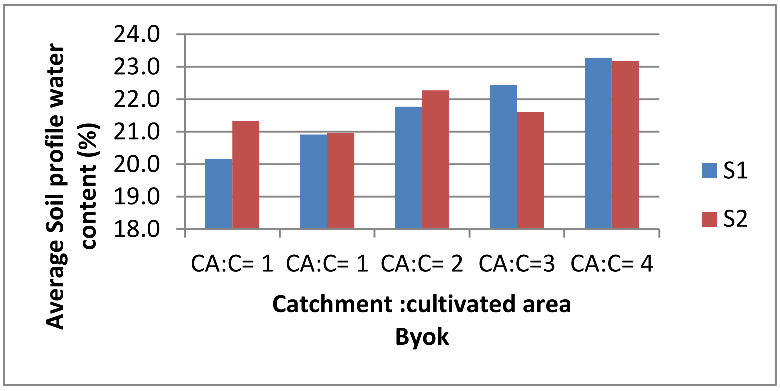


Figure (11): Replotting the effect of the ratio of catchment to cultivated area and catchment slope on average soil profile water content at Byok site.

3.3. Derivation of the Theoretical Ratio of Runoff to Runon Area

An attempt was also made to determine the suitable ratio of the runoff to runon (or ratio of catchment to cultivated area) based on a host of variables. The variable encompassed: annual crop evapotranspiration, design rainfall, runoff coefficient and efficiency factor. It is commendable to mention that standard procedure was followed in detail for calculating these variables, but the details were not given here because of limited space. However, the summary of the results are given in Table 1.

Table (1): Theoretical computation of ratio of catchment to cultivated area at the investigated sites.

Site	Wheat crop evapotranspiration, ETc (mm/annum)[1]	Design rainfall (mm)[2]	Runoff coefficient (-)[3]	Efficiency factor (-)[4]	Ratio of catchment to cultivated area (-1)
1.Chalook	505	252	0.10	0.75	13.4
2. Byok	448	312	0.12	0.75	4.8

The calculation was based on Penman-Monteith formula and the wheat crop coefficient during the months of the growing season.
It was based on the rainfall probability analysis using Weibull's formula.
A coefficient of 0.75 was used as reported by (8) for microcatchment
It was determined experimentally using runoff plots at both sites.
It was based on applying the formula 3.4

It is apparent from Table 1 that the ratio of catchment to cultivated area at Chalook site is 2.8 times as much the ratio as Byok Site. The high-water deficit (a big difference between ETC and design rainfall) is responsible for the higher theoretically computed value of the ratio at Chalook site. Based on the results obtained during the current study and by considering the economic aspects, it is recommended to use a runoff-runo ratio of 4 at Byok site. On the other hand, it is recommended to perform experiments at Chalook site with ratios beyond 4:1.

3.4. Grain Yield Modelling

An attempt was also made to predict wheat grain yield from annual rainfall, catchment slop and ratio of catchment to cultivated area using linear multiple linear regression. The database for this prediction involved the collected data at the two investigated sites during the growing season of 2022/2023. Table 2 depicts the parameters of the linear model along some selected performance indicators. It is evident from Table 2, each annual rainfall and ratio of catchment to cultivated area has a positive sign and plays an important role in increasing the grain yield.

The reverse may be true for catchment slope. Furthermore, the ratio of catchment to cultivated area has emerged to be the most effective factor affecting grain yield followed by annual rainfall depth. More than 91% of variation in grain yield can be attributed to variation in the indicated input variables.

Table (2): Parameters of the linear regression model along with some selected performance. indicators

$Y=B_o+B_1X_1+B_2X_2+B_3X_3$				Performance Indicators			
B_o	B_1	B_2	B_3	R^2	MBE	MAE	MAPE
-1.9027	0.0113	-0.0032	0.3296	0.913	0.000	0.169	9.717

Y= Grain yield (t/ha)
X1= Annual rainfall (mm)
X2= Catchment Slope
X3= Catchment cultivated area ratio (CA:C)

The low value for root mean square error (RMSE) indicates that the anticipated and observed values are well matched (26). Judging from mean biased error (MBE), it can be concluded that model neither overpredicted nor underpredicted the grain yield. The plot of the observed grain yield values versus the predicted ones in relation to line 1:1 indicated that most of the plotted points are situated on or close to the line 1:1(Fig.12). The proximity of the intercept of the linear relation from zero and correlation coefficient of its slopes from 1 are additional points in favour of the suitability model for predicting grain yield during runoff farming. Furthermore, the plot of bias (residuals) versus the observed values disclosed that the error of prediction has not a systematic distribution (Fig.13), denoting the appropriateness of the model for prediction (27).

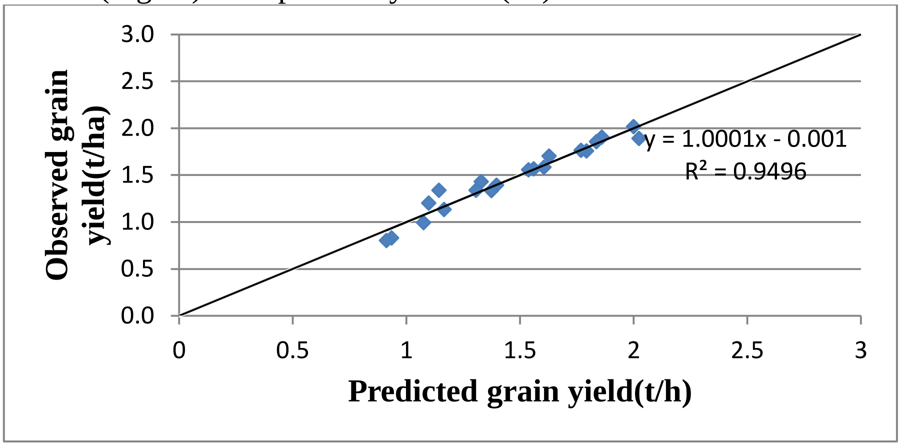


Figure (12): Plot of observed grain yield versus the predicted values from the proposed regression model.

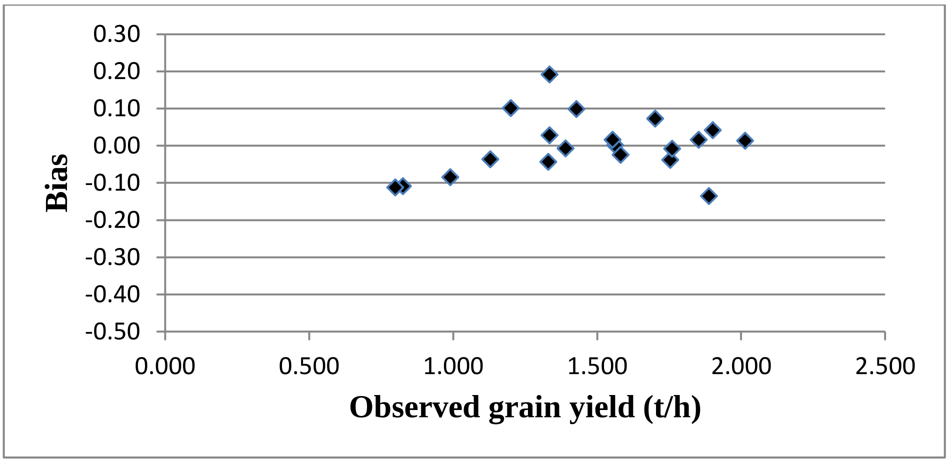


Figure (13): Plot of residuals of prediction model versus observed grain yield.

4. Conclusions

It can be concluded from the results during the current study that runoff farming leads to improvement in dry farming agriculture particularly in the rainfall zone sandwiched between 250 and 350 mm. Theoretical computation of catchment to cultivated area ratio revealed that three is the possibility of further improvement in crop output with a catchment to cultivated area ratio greater than four, particularly at sites with an annual rainfall of 250 mm. From an economic standpoint, the best catchment slope for runoff farming in this region and similar regions is 5%.

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تقييم زراعة الجريان السطحي في منطقتين مختلفتين لهطول الأمطار في المناخ شبه الجاف لمحافظة أربيل

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الملخص

تتعرض الزراعة الديمية للمخاطر فى المناطق الجافة وشبة الجافة بسبب قلة الامطار الساقطة وسوء توزيعها. ويمكن الاستفادة من مياه الجريان السطحى فى مثل هذه المناطق كمصدر بديل للمياه الجاهزة لتحسين انتاجية المحاصيل. وعلى هذا الاساس نفذت تجربتين حقليتين فى منقطتين مطريتين مختلفتين (جالوك وبايوك) لبيان تأثيرالتداخل بين خمس مستويات من نسبة مساحة التغذية الى المساحة المزروعة (0 و 1و 2 و 3 و 4) و ومستوين من انحدار الارض (5% و 10%) على نمو و حاصل الحنطة والاحتفاظ بماء التربة. ولتحقيق الاهداف المنشودة تم أنشاء 15 لوح لكل انحدارو لكل موقع. وكانت أبعاد الجزء السفلى للوح 2.5 م x 3 م والمستغل لزراعة المحصول وبدون ميل بينما استغل الجزء العلوي لتغذية الجزء السفلى بمياه الجريان السطحى بنفس عرض الجزء السفلى البالغ 2.5 م ولكن بأطوال مختلفة ومتناسبة مع نسبة مساحة التغذية ال المساحة المزروعة. وأشارت النتائج الى أزدياد مستمر لنمو وحاصل الحنطة مع أزدياد نسبة مساحة التغذية الى المساحة المزروعة. كما لوحظ تفوق الميل 5% على الميل10% ولكن لم تكون الفروقات أحصائية. وتشير نتائج الحسابات النظرية الخاصة بنسبة مساحة التغذية الى المساحة المزروعة الى أمكانية الحصول على حاصل أكبر مما حصل عليه من التجارب بأزدياد نسبة مساحة التغذية الى المساحة المزروعة فوق 4 وبصورة خاصة فى موقع جالوك. يعزى تفوق نمو ونتاج الحنطة فى موقع بايوك على الموقع جالوك الى وفره مياه الامطار فى الموقع الاول بدرجة أكبر. كما بنينت نتائج تحليل الانحداربأن عامل نسبة مساحة التغذية الى المساحة المزروعة من الاكثر العوامل تأثيرا على الحاصل ويليها عامل المطر السنوى. كما أتضحت من نتائج تحليل الانحدار تسبيب أكثر من 91% من الاختلاف فى حاصل الحنطة الى الاختلافات فى نسبة مساحة التغذية الى المساحة المزروعة والمطر السنوى وميل الارض.

الكلمات المفتاحية: حصاد المياه، تصميم هطول الأمطار، زراعة الجريان السطحي، نسبة المساحة المزروعة في مستجمعات المياه، نمذجة إنتاجية الحبوب.