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# WATER EFFICIENCY UNDER MIXED (CROP/LIVESTOCK) FARMING SYSTEM IN NILE DELTA AND UPPER EGYPT: 2. PRELIMINARY TRIAL TO DETERMINE WATER PRODUCTIVITY DURING GROWTH AND FATTENING PERIODS OF BUFFALO CALVES

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## SUMMARY

*Hundred and fifty farms practicing mixed (Crop/livestock) farming system were selected from three governorates: two in Delta El-Beheira (B) and Kafer El-Sheikh (K) representing buffalo – rice based system and one in Upper Egypt Qena (Q) for buffalo -sugar cane based system. The study objectives were to calculate water required to produce 1 kg live body weight gain from growing and fattening buffalo calves under the above mentioned system. Structured questionnaire was used to collect data on feeding and watering systems during growth and fattening. Water consumed was estimated in two production periods: growth from approximately 80 kg till 200 kg body weight and in two phases for fattening: the first between 210 and 340 kg and the second from above 340 to marketing weight (450 kg). Results showed that revenue (L.E/$m^3$ water) was LE. 5.37, LE. 4.30 and LE. 3.57 for growing calves in the three governorates K, B and Q, respectively. The corresponding figures for fattening claves were LE. 4.69, LE. 5.23 and LE. 4.35/ $m^3$. Water required to produce 1 kg body weight gain was 5.87 $m^3$, 6.46 $m^3$ and 8.95 $m^3$ for growing calves and 5.45 $m^3$, 4.96 $m^3$ and 6.12 $m^3$ for fattening calves for the three studied governorates, respectively. As strategic decisions may base on results of such studies, there is a real need for more investigation in this subject to get precise estimates on water consumption and efficiency.*

***Keywords: Growth, fattening, water efficiency, rice, sugar cane, Buffalo***

## INTRODUCTION

Improving water efficiency is undoubtedly important in accelerating agricultural development. Apart from low productivity, livestock have become a major concern for water productivity especially in the mixed farming system in Egypt for two reasons. Firstly, mismanagement has aggravated water scarcity through depletion and pollution. Secondly, little attention has been given to the integration of livestock and water management works. In this connection, it is vital to improve agricultural and livestock productivity by preventing water depletion and environmental degradation. Previous investments in agricultural water development in Sub-Saharan Africa (SSA) resulted in low returns and were environmentally and economically unsustainable due to poor integration of water and livestock development and their biases to crop productivity (Peden *et al.*, 2009). In order to better face the above-mentioned challenges of livestock and water integration, researchers have devised a livestock water productivity framework that comprises four strategies. These are planned feed sourcing, enhancing animal production, conserving water resources, and careful provision of drinking water (Peden *et al.,* 2007 and 2009). However, the framework only visualizes the bio-physical aspects of water and neglects the socio-economic aspect. In other words, the framework takes water as a sole input and ignores others such as labor, finance, time etc., which ultimately overestimate the Livestock Water Productivity (LWP) value.

The objectives of the present study were: to calculate water requirement to produce 1 kg of live body weight for buffalo growing and fattening calves under two mixed farming systems and to compare economic water efficiency for growing and fattening buffalo: in the Delta (rice and buffalo) and in Upper Egypt (sugar cane and buffalo).

## MATERIAL AND METHODS

***Study sample:***

Three governorates were selected geographically to represent buffalo farms in Delta (Kafer- El-Sheikh and EL-Beheira) and Upper Egypt (Qena) with considerable variation in environmental temperature. Table (1) shows temperature, humidity and temperature –humidity index in the studied governorates according to (Jamee *et al.*, 2005) Temperatures and humidity index were calculated from climate central laboratory data for year 2010. This study was conducted depending on primary data that were collected by interviewing farmers who rose fattening and grower buffalo calves within dairy or fattening farms under mixed farming system (buffalo/crops). Two buffalo farming systems are considered, buffalo – rice in Delta and buffalo – sugar cane in Qena. Two types of mixed farming system were studied in Delta to represent two sub-systems of buffalo production: in El-Beheira farmers raise buffalo more than cattle and other sub-system was in Kafr El-Sheikh where farmers raise cattle more than buffalo (MALR, Animal Wealth Development Sector, 2009).

***Data Collection:***

Data collection was conducted from October 2010 to February 2011, on 150 farms in the three governorates (fifty farms each). Questionnaire was designed and pre-tested for clarity on a limited number of farmers who showed good intention for cooperation. The questionnaire covered costs (feeds, labor and veterinary services) and revenues from manure and body weight gain. Most of labor of the studied farms was family type, but calculations considered wages of the hired labor as LE. 437, LE. 455 and LE. 421/month for k, B and Q, respectively. Feed ingredient prices and quantities are found in Annex (1) and( 2). Body weight gain price was calculated according to the calves' age (LE. 30, LE. 30 and LE. 31) for weaned claves from 80 kg till 200 kg. For calves in Phase I of fattening from (210 - 340 kg), prices were LE. 26, LE. 26 and LE. 27, while for phase II (350 till marketing at an average weight of 450 kg, prices were LE 24, LE. 24 and LE. 24.5 for K, B and Q, respectively). Division to two phases of fattening is important due to that daily weight gain, price of one kg live body weight and feed requirements are different. Livestock extension people in the studied governorates were trained and administered the questionnaire for data collection. Quantity of animal feeding, feeding costs and land irrigation water requirement for forages and some crops are presented in Annexes (1), (2) and (3).

***Water input for buffalo calves:***

It should be declared that water consumption calculated here is only that consumed during growth and fattening of the bull.

***Drinking water in summer and winter was calculated as follows:***

$$DW = \frac{WV}{NA} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:
DW = drinking water/bull
WV = Water volume,
NA = Number of growers and fattening animals.

***Calculations of water consumption through feeds were conducted as follows:***
***Green forages:***

$$AFA \quad \frac{\sum QGW + \sum QGS}{FPW + FPS} \quad \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

$$TWC = AFA * WF \quad \ldots\ldots\ldots\ldots\ldots(3)$$

Where:
AFA = Total areas in feddan of green forages fed to animal in winter and summer,
∑ QGY = Sum quantities of green forages feed to animal in winter and summer,
FPW = Feddan production of green forage in winter,
FPS = Feddan production of green forage in summer,
WF = Irrigation water required for one feddan of green forage in winter and summer,
TWC =Total water consumption to the animal from green forages over the year.

***Concentrate feeds mixture:***

$$WCF = \sum(I/FP)*W \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where:
WCF = Irrigation water from concentrates feed mixture ingredients/ animals,
∑(I/FP)*W= Sum of quantity of each ingredients/ Feddan Production of these Ingredient * irrigation water required to areas produced these Ingredient.

***Roughages:***

Water used to produce cereals and roughages. The irrigated water for cereals was divided into two quantities for main crop and roughages according to marketing values of both of them.

***Studied traits:***

***Herd size:*** absolute total number of animals in herd categories, without milking animals.
***Herd structure:*** was calculated as percentage of herd categories.
***Animal Unit (AU):*** standard coefficients were used to calculate herd size expressed in AU and to calculate requirements from feed and labor. Average daily gain, total gain per month was divided/30 days.
***Economical traits***: were variable costs (VC) (feeds, family labor and veterinary services), total revenues (TR) from body weight gain and manure, Gross Margin GM = TR – VC.

***Water efficiency:***

Revenues of water unit (LE./$M^3$) in growers and fattening revenues / kg weight gain.

$$WE = \frac{\sum \text{values of all outputs produced (L.E.)}}{\sum \text{Water consumption}} \quad ...(5)$$

Where WE = water efficiency (L.E/$m^3$),
Total value of all outputs = Total daily weight gain + manure revenues,
Total water consumption = water for green forage, concentrates feeds, straws, drinking and water for other uses.

Statistical analysis using the SAS program (SAS, 2004) was applied to calculate economical efficiency, measures and averages and percentages of different biological and economical variables. One model was used to study factors affecting live gain weight: governorate and levels of concentrates in the rations. The model was used to evaluate variation among governorates and level of concentrate in the rations on live body weight gain, details of this model is shown below:

***Statistical Model:***

$Y_{ijk} = \mu + G_i + C_j + (G_i * C_j) + e_{ijk}$

where:

$Y_{ijk}$ = daily weight gain of the animal,
$\mu$ = overall mean,
$G_i$ = the effect of governorate
where i = 1 = K, 2=B and 3 = Q,
$C_j$ = the effect of quantity of concentrate feed where j = 1= 2-3, 2= 4-5 and 3 >5 kg,
$e_{ijk}$ = the residual effect

Significances among means were performed through Duncan Multiple Range Test (Duncan, 1955).

## RESULTS AND DISCUSSION

Table (2) and Table (3) shows herd structure: El-Beheira had the highest herd size (12.3 AU) followed by Kafer El-Sheikh (10.6 AU) and then Qena (9.80 AU). The ranking order, concerning absolute numbers, was K 23.4, B (20.7) and Q 19.8). Concerning 4 – 6 months heifers, K has higher percentage ($P \leq 0.05$) compared with B and Q. Moreover, B was higher ($P \leq 0.05$) than Q.

Differences might be due to that farmers in K were keen to raise heifers to pregnancy stage to be sold in good price. Differences could be attributed, also, to feeding costs which were higher in Q; therefore farmers tended to sell their animals at young age. El-Beheira farmers select good heifers for replacement and the rest is sold at young age. The same trend was found for heifers of 7-12 months in Q which were less ($P \leq 0.05$) in number than in the other two governorates (Table 3). For growing bulls, significant differences ($P \leq 0.05$) were found among K, Q and B. These differences might be due to the lower milk price in K and therefore, farmers used it for suckling calves. Qena farmers prefer fattening calves. It might be a result of milk market, which has small capacity. Therefore, they keep calves till marketing weight. Number of fattening calves in phase I in Q was higher ($P \leq 0.05$) compared to K and B. This might be attributed to that farmers used to breed calves which are easy to sell and because Qena farmers have good experience in fattening practices. Numbers and percentages in phase II of fattening were higher ($P \leq 0.05$) in B compared to K and Q.

Results indicated that no significant effect of governorate was shown on daily weight gain (DWG) for growing calves (Table 4). Daily weight gain in Q was significantly higher ($P \leq 0.05$) than both in K and B fattening calves. The difference might be attributed to that farmers in Q have good experience in fattening calves. Also, availability of feed resources in Qena such as sugar cane molasses and sugar cane tops may encourage farmers to adopt fattening enterprises. Better Calf rearing system in Q is practiced by adding good starter with suckling milk in the second month of the suckling period. Also, some farmers keep baby calves with mothers for suckling more than three months, where they noticed that long suckling period prepare calves more proper for faster fattening.

In addition to, milk market in most of Upper Egypt has low capacity and so, farmers prefer to give milk to baby calves. As much as concentrate level is offered, DWG increase. These differences might be attributed to that concentrate feed mixture has much nutritional values than green forage or straw for growing calves. Concentrate feed mixture has better feed conversion and nutritive values than green forage and straw. Digestion coefficient of concentrate ranged between 65% and 90% while for roughages they ranged from 50% to 70% (Applied and Scientific Animal Feeding Book, 1998). Concentrate levels within the three governorates showed the same trend as concentrate levels in diets except in B where concentrate level 2-3 and 4-5 kg/day showed no significant differences.

Table (5) shows variable costs, revenues and gross margin for growing buffaloes in the three governorates. Winter green forage (Berseem/Alfalfa) quantity in K was lower ($P \leq 0.05$) than in Q and B. This finding might be due to that farmers rely on concentrate feed more in K than in both Q and B. For summer green forage (Darawa/ Sorghum) the quantity in Q was higher ($P \leq 0.05$) than in K and B. It might be due to that in K and B farmers tend to cultivate more profitable crops such as rice than green forage. However, framers in K and B feed their animals more berseem hay in summer to compensate green forage. El-

Ashmawy *et. al.* (2006) reported that cultivated area of berseem in El-Beheira ranged between 37%and 43% of the total winter crops area while in summer rice represents 31% to 48%, while corn, darawa with elephant grass and kidney bean in total represent only 4.8%. Khalil and El-Ashmawy (2008) found that berseem and alfalfa represented 31.8 % of winter crops area in Q, while in summer sorghum, alfalfa and darawa represented 52.8% of summer crops.

Cost and revenues of the growing calves are presented in Table (5). Framers feed their animals' higher green forage in summer Darawa or Sorghum. Concentrate feeds quantities in summer are higher than in winter (berseem or alfalfa) in the study. The period of concentrate consumption for growing calves was calculated from sampled farms in the three governorates, to be 180, 180 and 200 days for K, B and Q, respectively. Revenues were calculated from body weight gain and manure. Farms in K showed higher total revenue followed by Q and B. The differences might be due to the availability of feed over the year especially in winter, or animals may have better feed conversion or good farm management. Total revenue of growing buffalo calf in B was lower than that in Q and K which might be due to that total gain weight was lower in B.

Manure revenue in K was higher than those in the other two governorates and B was higher than Q. These differences might be attributed to the stable ground type, cement produce less than dusty, or according to feeding types. Desert nearby of B requires more organic fertilizer so the price is higher. Gross margin showed that growing buffalo calves in B was more efficient followed by those of Q.

Table (6) shows variable costs, revenues and gross margin for fattening buffalo in the studied governorates. Winter green forage quantity was different ($P \leq 0.05$) among K, Q and B. These differences might be due to farm management in B and K used to feed fattening calves on third and fourth berseem cuts, thus in K and B calves are fed more berseem than in Q. For summer green forage, K was lower ($P \leq 0.05$) than both Q and B which might be attributed to that farmers in K cultivate less green forage area. Also, Kafer El-Sheikh used to cultivate darawa as summer green forage; the yield per land unit is not as much as alfalfa that cultivated in Q, or sorghum in B.

Farmers in Q use more ($P \leq 0.05$) concentrate for fattening claves than in K and B due probably to lack of summer green forage availability in most of Q farms. Framers in K and B feed their animals more corn and wheat bran in addition to concentrate to improve the feeding values mainly in summer to compensate lack of green forage or concentrate reduction especially in summer. Concentrate feed quantities in summer are higher than in winter. The figure in table 6 represents overall average of summer and winter consumption. The period of concentrate feeding was calculated from sample of farms in the three governorates as, 210, 200 and 210 days per year for K, Q and B, respectively.

Revenues for Q and B were higher compared to K. This might be due to concentrate quality, balanced rations or genetics of fattening calves. The differences might be also, due to the lower daily gain in K and B compared to Q or farm management. Total revenues from fattening buffalo calves in B and K were lower than that in Q. This might be due that total weight gain was lower in B and K. Differences might be due to live animal market prices. Manure quantity, and price and revenue in K and B were higher than Q. These differences might be attributed to stable ground type, cement produce less than dusty ground type or according to feeding types or to that demand nearby new reclaimed areas to more manure, make the price higher in B and K. Total revenue and gross margin showed that fattening calves in Q was more efficiently followed by B and K. The main reason may be attributed to that daily gain was significantly lower ($P \leq 0.05$) in B and K compared to Q.

***Drinking water consumption for young stock and fattening animals:***

Table (7) shows drinking water consumption as an average of summer and winter. The results showed significant differences among the three studied governorates in average drinking water consumption for claves. Q had higher ($P \leq 0.05$) water used than B and K, and B was higher ($P \leq 0.05$) than K in suckling claves & heifers, heifers 4 – 6 months and heifers 7 – 12 months age, grower claves 80 – 240 kg and phase II fattening claves.

Consumption of pregnant heifers and phase I fattening calves of Q was significantly higher ($P \leq 0.05$) than in B and K. Kafer El-sheikh was higher ($P \leq 0.05$) in water consumption than B, these differences might be attributed to ambient temperature or feeding types. Cleaning water was suggested to be 20% of total drinking water consumption. Mulugeta Tutu (2006) reported that the Livestock tropical unit drinking water per day 9.92 in summer in 32 º C

***Water efficiency:***

Results in Tables (8) and (9) show the water return (LE./$m^3$) for grower and fattening buffalo in the three studied governorates. Kafer El-Sheikh was better in water efficiency for grower calves compared to Q and B while, B was more efficient for fattening calves compared to Q and K in terms of $m^3$ required to produce 1 kg live body weight or revenue/$m^3$ of water.

These results might be attributed to that farms have better management and calf rearing in K and B in addition ambient temperature in Q might be have a negative role in growing and fattening periods. The difference in grower efficiency might be due to concentrate quantity in ration for K was the highest. Gebreselassie *et. al*. (2008) reported LWP values of USD 0.3 - 0.7 $m^3$. The authors suggest that feed, age, breed and herd structure account for variability in LWE. Gawelly and Mohamed (2005) reported that ton live body weight needs 9190.74 $m^3$. The same author found that 1 $m^3$water used to produce 1 kg of live weight has L.E. 4.82 return. Mulugeta Tutu (2006) reported that the Livestock tropical unit water requirement from crop residuals + grass + drinking water per year were 1703 $m^3$.

## CONCLUSION

Livestock water efficiency was calculated with using systems approach. The present study has paramount importance in investigating. The study yielded some preliminary estimates for water consumption and water efficiency for growing and fattening buffalo calves in mixed crop- livestock systems in Delta and Upper Egypt. Fattening calves utilized water more efficiently to gain weight than growing calves. Also Buffalo rice surpassed buffalo – sugar cane system in water efficiency Improving forage crops water efficiency would improve livestock production water efficiency. Growth rate of fattening buffalo calves would be improved by using good quality concentrates. As strategic decisions may be base on results of such studies, there is a real need for more investigations in this subject to get precise estimates on water consumption and efficiency

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**Table 1. Temperature, humidity and temperature –humidity index in studied governorates**

| Governorates/ /seasons | Temperature | Humidity | Temperature-Humidity index |
|---|---|---|---|

| | **Minimum** | **Maximum** | **Minimum** | **Maximum** | **Minimum** | **Maximum** |
|---|---|---|---|---|---|---|
| K summer | 14.4 | 33.9 | 34.3 | 93.0 | 30 | 35 |
| K winter | 9.7 | 24.7 | 23.0 | 56.7 | 30 | 33 |
| B summer | 12.5 | 34.2 | 35.7 | 93.3 | 29 | 35 |
| B winter | 9.7 | 24.1 | 30.7 | 67.0 | 28 | 30 |
| Q summer | 21.0 | 39.4 | 35.7 | 70.8 | 34 | 42 |
| Q winter | 9.0 | 27.1 | 30.7 | 59.7 | 28 | 34 |

**Table 2. Buffalo herd size in Kafer El-sheikh (K), El-Beheira (B) and Qena (Q)**

| **Items** | K | | B | | Q | |
|---|---|---|---|---|---|---|
| | N | $(\bar{X})$ ±SE ( AU) | N | $(\bar{X})$ ±SE (AU) | N | $(\bar{X})$±SE (AU) |
| **Growing animals** | | | | | | |
| Claves & heifers(1-3 months ) | 3 | 1.63±0.3(0.3) | 13 | 2.00±0.4 (0.4) | 28 | 1.71±0.2 (0.3) |
| Heifers ( 4-6 months ) | 7 | $4.09^{a}$±2.1(1.6) | 6 | $2.50^{b}$±0.6 (1) | 21 | $1.48^{c}$±0.2 (0.5) |
| Heifers ( 7-12 months) | 11 | $2.76^{a}$±1.5(1.7) | 15 | $2.60^{a}$±0.6 (1.6) | 22 | $1.55^{b}$±0.2 (0.9) |
| Heifers > (12 months ) | 6 | 1.60±0(1.3) | 2 | 1.50±0.0(1.2) | 6 | 1.73±0.3 (1.4) |
| Pregnant heifers | 5 | 2.00±0(1.6) | 4 | 2.00±0.7 (1.6) | 7 | 1.71±0.3 (1.4) |
| **Growing and fattening bulls** | | | | | | |
| Grower claves | 15 | $6.97^{a}$±6.5(1.4) | 9 | $1.67^{c}$±0.3 (0.3) | 19 | $5.15^{b}$±1.3 (1) |
| Calves in phase I of fattening | 25 | $2.58^{b}$±8.6(1.3) | 31 | $2.00^{b}$±0 (1) | 38 | $3.53^{a}$±0.6 (1.8) |
| Claves in phase II of fattening | 25 | $1.80^{c}$±0(1.4) | 31 | $6.50^{a}$±5.5 (5.2) | 38 | $3.00^{b}$±0.6 (2.4) |
| Total | | 23.43 (10.6) | 111 | 20.77(12.3) | 101 | 19.86 (9.8) |

N : Number of farms * percentage followed by different letter differ significantly ($P \leq 0.05$)
AU: Animal Unit

**Table 3. Buffalo herd structure, in Kafer El-sheikh (K), El-Beheira (B) and Qena (Q)**

| **Items** | K | | B | | Q | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| **Growing animals** | | | | | | |
| Claves & heifers (1- 3 months ) | 3 | 7 | 13 | 10 | 28 | 9 |
| Heifers ( 4-6 months ) | 7 | 17 | 6 | 12 | 21 | 7 |
| Heifers ( 7-12 months ) | 11 | 12 | 15 | 13 | 22 | 8 |
| Heifers > (12 months ) | 6 | 7 | 2 | 7 | 6 | 9 |
| Pregnant heifers | 5 | 9 | 4 | 10 | 7 | 9 |
| **Growing and fattening bulls** | | | | | | |
| Grower claves | 15 | 30 | 9 | 8 | 19 | 26 |
| Calves in phase I of fattening | 25 | 11 | 31 | 10 | 38 | 18 |
| Claves in phase II of fattening | 25 | 8 | 31 | 31 | 38 | 15 |
| Total | 97 | 100 | 111 | 100 | 101 | 100 |

N : Number of farms

**Table 4. Least squares means (LSM± SE) for daily weight gain (kg) of growers and fattening**

| Effects | No. of farms | Daily weight gain of (growers) (kg/day) | | No. of farms | Daily weight gain of fattening bulls (kg/day) | |
|---|---|---|---|---|---|---|
| | | LSM | ± SE | | LSM | ± SE |
| **Overall mean** | 43 | 0.57 | - | 94 | 1.06 | - |
| **Governorates** | | | | | | |
| K | 15 | 0.63 | 0.3 | 25 | $1.05^{b}$ | 0.2 |
| B | 9 | 0.59 | 0.5 | 31 | $1.07^{b}$ | 0.2 |
| Q | 19 | 0.55 | 0.3 | 38 | $1.13^{a}$ | 0.2 |
| **Concentrate feed** | | | | | | |
| 1 (2 – 3 kg/animal /day) | 15 | $0.44^{c}$ | 0.3 | 36 | $0.84^{c}$ | 0.2 |
| 2 (4 – 5 kg/ animal/day) | 20 | $0.61^{b}$ | 0.3 | 33 | $1.07^{b}$ | 0.2 |
| 3 (> 5 kg/animal/day) | 8 | $0.71^{a}$ | 0.5 | 25 | $1.34^{a}$ | 0.2 |
| **Concentrate feed * Governorate** | | | | | | |
| 1 (2 – 3 kg/animal /day) K | | $0.43^{c}$ | 0.06 | | $0.86^{c}$ | 0.03 |
| 2 (4 – 5 kg/ animal/day) K | | $0.69^{b}$ | 0.04 | | $1.03^{b}$ | 0.04 |
| 3 (> 5 kg/animal/day) K | | $0.78^{a}$ | 0.06 | | $1.26^{a}$ | 0.05 |
| 1 (2 – 3 kg/animal /day) B | | $0.50^{c}$ | 0.06 | | $0.84^{c}$ | 0.03 |
| 2 (4 – 5 kg/ animal/day) B | | $0.58^{c}$ | 0.06 | | $1.11^{b}$ | 0.03 |
| 3 (> 5 kg/animal/day) B | | $0.70^{a}$ | 0.11 | | $1.27^{a}$ | 0.04 |
| 1 (2 – 3 kg/animal /day) Q | | $0.39^{c}$ | 0.04 | | $0.82^{c}$ | 0.03 |
| 2 (4 – 5 kg/ animal/day) Q | | $0.58^{b}$ | 0.04 | | $1.06^{b}$ | 0.03 |
| 3 (> 5 kg/animal/day) Q | | $0.67^{a}$ | 0.07 | | $1.49^{a}$ | 0.03 |

[abc] means within a column with different superscript differ significantly ( P<0.05).

**Table 5. Total variable costs and revenues for growing buffalo calves[1]**

| Items | K | | B | | Q | |
|---|---|---|---|---|---|---|
| | N | $(\overline{X})$±SE | N | $(\overline{X})$±SE | N | $(\overline{X})$±SE |
| Berseem or alfalfa/animal/day (kg) | 7 | $15.1^{b}\pm 1.0$ | 9 | $19.6^{a}\pm 1.7$ | 25 | $18.6^{a}\pm 1.8$ |
| Daraw or sorghum /animal/day (kg) | 6 | $9.7^{b} \pm 0.9$ | 8 | $10.4^{b} \pm 0.8$ | 22 | $12.5^{a} \pm 0.8$ |
| Concentrate[2] /animal/day (kg) | 10 | $3.5^{a} \pm 0.2$ | 9 | $2.5^{b} \pm 0.1$ | 23 | $2.8^{b} \pm 0.2$ |
| Wheat straw animal /day (kg) | 8 | $2.2^{a}\pm 0.1$ | 13 | $2.7^{b} \pm 0.1$ | 22 | $1.8^{b} \pm 0.2$ |
| Berseem hay[3] /animal/day (kg) | 3 | 1.5 ± 0.8 | 4 | 1.5 ± 0.2 | 5 | 1.2 ± 0.4 |
| Feeding costs (L.E) | | 2358 | | 2160 | | 2331 |
| Labor costs (L.E) | | 131 | | 100 | | 106 |
| Veterinary costs (L.E.) | | 46 | | 52 | | 37 |
| Total variable costs (L.E.) | | 2536 | | 2312 | | 2474 |
| Manure quantity/farm ($m^3$) | 5 | 5.6 | | 6.2 | 6 | 4.5 |
| Manure price (L.E./ $m^3$) | 4 | $28.09^{a}\pm 0$ | 40 | $20.70^{b}\pm 1.1$ | 7 | $23.74^{b}\pm 1.5$ |
| Manure revenue (L.E.) | 5 | 157 | | 128 | 7 | 107 |
| Weight gain revenue (L.E.) | | 3402 | | 3363 | | 3410 |
| Total revenue (L.E.) | | 3559 | | 3491 | | 3517 |
| Gross margin/animal (L.E.) | | 1023 | | 1179 | | 1043 |

1: Growing periods were 180, 200 and 190 day for the three governorates, respectively
2: Farmers sometimes add corn and wheat bran in summer it was included in feeding costs
3: Berseem hay used in summer and more concentrate feed used in summer
N : Number of farms

**Table 6. Variable costs and revenues for buffalo fattening bulls till marketing weight.**

| Items | K | | B | | Q | |
|---|---|---|---|---|---|---|
| | N | $(\overline{X})$±SE | N | $(\overline{X})$±SE | N | $(\overline{X})$±SE |
| Berseem or alfalfa/animal/day (kg) | 30 | $20.6^{b}$ ± 1.0 | 31 | $25.0^{a}$ ± 1.7 | 33 | $15.5^{c}$ ± 1.8 |
| Daraw/sorghum/ animal/day (kg) | 26 | 8. $2^{b}$ ± 0.9 | 31 | $11.5^{a}$ ± 0.8 | 33 | $10.5^{a}$ ± 0.8 |
| Concentrate /anima/day (kg) | 24 | $3.6^{b}$ ± 0.2 | 31 | $3.5^{b}$ ± 0.1 | 32 | $4.5^{a}$ ± 0.2 |
| Wheat straw animal /day (kg) | 36 | $5.3^{ab}$ ± 0.1 | 30 | $5.7^{a}$ ± 0.1 | 32 | $4.9^{b}$ ± 0.2 |
| Corn/animal/ day (kg) | 20 | $^{a}$ ± 0.4 | 17 | $2.0^{a}$ ±02 | 12 | 1.5 $^{b}$ ± 0.3 |
| Wheat bran/animal/ day/(kg) | 15 | 1.5 ±0.2 | | 1.0 ± 0.1 | | 1.0 ± 0.2 |
| Av. Feeding costs (L.E) | | 4460 | | 4379 | | 4493 |
| Av. Labor costs (L.E) | | 171 | | 113 | | 166 |
| Av. Veterinary costs (L.E.) | | 46 | | 52 | | 37 |
| Total variable costs (L.E.) | | 4677 | | 4544 | | 4696 |
| Manure quantity/farm ($m^3$) | 25 | 7.7 | 33 | 8.2 | 35 | 6.2 |
| Manure price (L.E.) | 25 | $28.1^{a}$±0 | 40 | $25.7^{b}$±1.1 | 35 | $23.7^{c}$±1.5 |
| Av. Manure revenue (L.E.) | 26 | 216.3 | 33 | 210.7 | 35 | 147.2 |
| Av. W eight gain revenue (L.E.) | | 5513 | | 5618 | | 5876 |
| Total revenue (L.E.) | | 5629 | | 5829 | | 6023 |
| Gross margin (L.E.) | | 952 | | 1285 | | 1327 |

Berseem feeding only from third and fourth cuts for fattening animals
Fattening periods were 210, 200 and 210 day for three areas respectively
Means followed by different letters differ significant ($P \leq 0.05$)

**Table 7. Total drinking water (in liter) during the consumption period for youngstock and fattening calves**

| Items | K | B | Q |
|---|---|---|---|
| Claves & heifers 1-3 months | $2573^{c}$ | $2975^{b}$ | $3455^{a}$ |
| Heifers 4-6 months | $5566^{c}$ | $6023^{b}$ | $6223^{a}$ |
| Heifers 7-12 months | $10623^{c}$ | $11485^{b}$ | $12089^{a}$ |
| Heifers served for pregnancy | $15653^{b}$ | $15056^{c}$ | $17206^{a}$ |
| Pregnant heifers | $17885^{b}$ | $16425^{c}$ | $19163^{a}$ |
| **Fattening calves** | | | |
| Grower Claves (80 – 200 kg) | $5566^{c}$ | $6023^{b}$ | $6223^{a}$ |
| Phase I (210-340 kg) | $10129^{b}$ | 9125c | $10919^{a}$ |
| Phase II( 350 – (450 kg) marketing weight | $13870^{b}$ | $13688^{c}$ | $15148^{a}$ |

Source: personal communication *Figures followed by different letter differ significantly ($P \leq 0.05$)

**Table 8 Water consumption, revenues and water efficiency for growth period**

| Items | K | B | Q | Average |
|---|---|---|---|---|
| Length of growth period (days) | 180 | 190 | 200 | 190 |
| Drinking water/ growth periods ($m^3$) | 5.57 | 6.02 | 6.22 | 5.94 |
| Green forage area feed/animal (kirat)/animal | 0.63 | 0.97 | 1.51 | 1.04 |
| Water from green forage/animal/($m^3$) | 112 | 173 | 374 | 220 |
| Water from concentrate feed /animal/($m^3$) | 272 | 190 | 218 | 227 |
| Water from straws/animal/($m^3$) | 272 | 353 | 385 | 337 |
| Cleaning water /animal/($m^3$) | 1.11 | 1.20 | 1.24 | 1.18 |
| Total water consumption./animal/($m^3$) | 663 | 723 | 985 | 790 |
| Total weight gain for animal (kg) | 113 | 112 | 110 | 106 |
| Total revenue/animal / (LE.) | 3559 | 3491 | 3517 | 3522 |
| Animal revenue per water unit (LE./$M^3$) | 5.37 | 4.83 | 3.57 | 4.59 |
| water requirements ($m^3$)/ 1 kg live weight from growers | 5.87 | 6.46 | 8.95 | 7.45 |

Water used for animal cleaning was suggested to be 20 % of drinking water. kirat (175 $m^2$)

**Table 9. Variable costs, revenues and water efficiency for fattening**

| Items | K | B | Q | Average |
|---|---|---|---|---|
| Length of fattening periods (days) | 210 | 210 | 200 | 207 |
| Drinking water for fattening period* ($m^3$) | 12.00 | 11.41 | 13.03 | 12.15 |
| Green forage feeding areas (kirat)/animal | 0.58 | 0.94 | 1.24 | 0.92 |
| Water from green forage/animal/ ($m^3$) | 103 | 107 | 167 | 126 |
| Water from concentrate feed /animal/ ($m^3$) | 547 | 474 | 465 | 495 |
| Water from straws/animal/ ($m^3$) | 537 | 520 | 749 | 602 |
| Cleaning water /animal/($m^3$) | 2.40 | 2.28 | 2.61 | 2.43 |
| Total water consumption/animal/ ($m^3$) | 1201 | 1115 | 1384 | 1233 |
| Total weight gain for animal (kg) | 220.5 | 224.7 | 226 | 223.7 |
| Total revenue/animal/(LE.) | 5629 | 5829 | 6023 | 5827 |
| Animal revenue per water unit (LE./$M^3$) | 4.69 | 5.23 | 4.35 | 4.76 |
| water requirements ($m^3$) / 1 kg live body weight from fattening animal | 5.45 | 4.96 | 6.12 | 5.51 |

**Annex 1 Prices and quantity of green forage per feddan**

| Feed ingredients | Average production/feddan (Ton) | Average production/kirat (Ton) / 4 cuts | Average production/ kirat (kg) | Price /kg (L.E.) | Feeding periods |
|---|---|---|---|---|---|
| Berseem in K | 41.29 | 1.877 | 469 | 0.27 | 90 |
| Berseem in B | 31.31 | 1.566 | 391 | 0.22 | 90 |
| Berseem in Q | 28.86 | 1.443 | 361 | 0.21 | 40 |
| Daraw in K | 11.86 | 0.539 | 539 | 0.18 | 70 |
| Daraw in B | 13.38 | 0.608 | 608 | 0.20 | 60 |
| Daraw in Q | 14.00 | 0.636 | 636 | 0.21 | 50 |
| Alfalfa in Q | 42.00 | 1.909 | 477 | 0.27 | 365 |
| Sorghum in B | 39.00 | 1.773 | 591 | 0.15 | 80 |

**Annex2. Concentrate feed, straws and conservation green forage prices used in the in studied areas**

| Feed ingredients | Kafer El-Sheikh | | El-Beheira | | Kafer El-Sheikh | |
|---|---|---|---|---|---|---|
| | Price (L.E.) | Feeding periods (days) | Price (L.E.) | Feeding periods (days) | Feeding periods (days) | Feeding periods (days) |
| Concentrate feed | 2330 | 365 | 2145 | 365 | 2322 | 365 |
| Wheat straw | 700 | 360 | 800 | 365 | 1000 | 365 |
| Rice straw | 250 | 35 | 300 | - | - | - |
| Berseem hay | 700 | 80 | 700 | 60 | 1000 | 60 |

**Annex3. Water requirements for green forage (feddan) and crops in the studied areas**

| Types of green forage | Water requirement in Delta ($m^3$/feddan) | Water requirement in Upper Egypt ($m^3$/feddan) |
|---|---|---|
| Berseem | 2875 | 4041 |
| Sorghum | 2904 | 3808 |
| Maize | - | 3373 |
| Soya Bean | 2768 | 3712 |
| Alfalfa | - | 8654 |
| Darawa | 3396 | 6542 |
| Wheat | 1720 | 2355 |
| Sugar cane | - | 9964 |
| Rice | 6349 | - |

Source: Animal wealth development sector – Published by: Economic Affairs Sector, 2008

# كفاءة المياه تحت نظم الإنتاج المختلطة (محاصيل- إنتاج حيوانى) فى مصر. 2- محاولة أولية لتقدير كفاءة المياه للعجول الجاموسى أثناء مرحلتى النمو والتسمين

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تم إختيار 150 مزرعة مختلطة (بها الانتاج النباتى والحيوانى) فى ثلاثة محافظات اثنتان منهما فى الدلتا وهما (كفرالشيخ والبحيرة) واخرى فى الوجه القبلى وهى قنا ليمثلوا نظامين انتاجيين مختلفين وهما انتاج الجاموس مع وجود محصول الارز فى الدلتا وأنتاج الجاموس مع انتاج محصول قصب السكر فى مصر العليا. كان إختيار المزارع على أساس وجود حيوانات منتجة للبن او اللحم أو الاثنين معا. الهدف من هذه الدراسة كان حساب كمية المياه اللازمة لانتاج 1 كجم لحم سواء كان ذلك فى مرحلة النمو او مرحلة التسمين للعجول الجاموس. أيضا حساب الكفاءة الاقتصادية للمتر المكعب من المياة (جنية/م$^3$ فى كل محافظة. تم عمل استبيان ميدانى لجمع البيانات من مربى الجاموس ، وتم الاستعانة ببعض البيانات السنوية المنشورة فى إحصائيات وزارة الزراعة. فى النمو تم تحددها ما بعد الفطام من80 كجم تقريبا الى حوالى 200 كجم وهى ما تسمى مرحلة النمو ثم مرحلة التسمين الاولى من وزن حوالى 210 كجم الى حوالى 340 كجم وزن حى ثم مرحلة التسمين الثانية (اكثر من 340 كجم الى عمر التسويق) الذى يترواح من 450 كجم وزن حى). وقد أظهرت النتائج ان العائد من وحدة المياه ( 1 مترمكعب) من عجول النمو كانت 5.37 و 4.83 و 3.57 و جنيه للمتر المكعب وكانت للتسمين بمتوسط المرحلة الاولى والثانية 4.69 و5.23 و 4.35 ، جنية للمترالمكعب لكل من كفر الشيخ، والبحيرة ، قنا على التوالى. كما أظهرت النتائج أيضا ان كمية المياه التى يحتاجها 1 كجم من الوزن الحى هى 5.87 و 8.95 و 6.46، متر مكعب فى مرحلة النمو مقابل 5.45 ،4.96، 6.12 م$^3$ فى مرحلتى التسمين لنفس محافظات الدراسة على التوالى.