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Case Study **Open Access**

Impact of Agricultural Engineering Practices on Farm Management: A Case Study of Gharo Model Farm

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Abstract
Effective agricultural practices can improve the farm management system. However, still today many farmers or inhabitants are not able to follow modern, sustainable and environment-friendly methods in farming systems. This paper describes the importance of agricultural engineering practices in farm management system. The extensive research was conducted at Gharo Model Farm, located at south-east of Gharo, Sindh – Pakistan in 2012. The farm was facing serious problems of water scarcity, pests, fruit dropping, weeds and lack of management. After rehabilitation of the farm there was an improvement in the overall farming operations. Due to cultural practices, land leveling and water channeling operations, a uniform look among plantation developed and time to fill the irrigation water in to the basins also decreased. Due to effective pesticide operation, the overall mealy bugs and termites appearance reduced by 95%. Application of 30 – 40 kg of organic manure increased the water retention capacity within the soil upto some extent. By the application of Single Super Phosphate (SSP) soil pH was reduced. The average water consumption from 6486 m^3/acre was reduced to 4715 m^3/acre which was 27% less than the past irrigation practices respectively. Split dosage of NPK (1200:750:300) grams per plant, along with 2 kg/acre of 5% zinc increased the yield of guava and sapota up to 33% and 41% respectively which is an ultimate gain.
Keywords: Agricultural Engineering, Farm Management, Pesticide, Fertilizers, Organic Manuring, Fruit Dropping, Gharo, Pakistan.

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INTRODUCTION

Agriculture is the primary step to growth in a nation. The economic growth rate of any state can be more easily promoted through sustaining sufficient food production. Among all other growth parameters, engineering is a critical component of agriculture sector which can help to address challenges associated with crop production (Mbamba, 2008). In the early years of the Green Revolution, agricultural engineering made many technical contributions to reduce drudgery and help increase labour productivity (Stout, 2007). Agricultural Engineering is the discipline that deals with the design, production, utilization and management of technical means and processes for production, storage, treatment and processing of agricultural goods, plants and animal products, post-harvest technology (Biggs *et al.,* 2003). Agricultural engineering and mechanization aims at increasing land and labour efficiency, serving to extend agricultural area, saving resources (seed, fertilizer, water) and energy, improving product quality, protecting the environment, saving sustainability of agricultural production, reducing hard work and drudgery, improving operators safety, creating attractive jobs for men and women to prevent rural exodus, improving farm machinery management and multiform use, and increase farm income (Kosutic *et al.,* 2007).

In rural areas, of many developing countries farmers are facing many social, economic, cultural and environmental problems because very few farmers or inhabitants are able to follow modern, sustainable and environment-friendly methods in farming systems. Therefore nowadays, agricultural engineers around the globe are applying their engineering knowledge and skills to boost up the agriculture and food sector of their state (Akubuo *et al.,* 2006). Agricultural Engineers are utilizing their modern techniques, systems and machines for the production of better food and services in order to improve agricultural practices with effective use of machinery and farm power respectively. Agriculture engineers design, fabricate and installs agricultural machines, construction of farm structures, processing and storage of product for better food production

(Field *et al.,* 2007). Agriculture sector is accelerated in United Kingdom, Saudi Arabia, France, Thailand etc. with joint effort of farmers and agricultural engineers. Agricultural Engineering is the bedrock of agricultural development and its negligence is a potential threat to the future survival of farm management system in any country (Mijinyawa, 2005).

Considering the above facts in view, the current research paper represents an extensive work which was conducted in the arid region of Gharo at a private farmhouse i.e. Gharo Model Farm, located at south-east of Gharo, Sindh – Pakistan. The primary focus of this research was to evaluate the impact of agricultural engineering practices on farm management techniques by utilizing effective systems and machines for better production of the fruit crops in the farm respectively.

MATERIALS AND METHODS

Location

The study was undertaken in the arid region of Gharo in month of October, 2012 at a private farmhouse located at south-east of Gharo, Sindh – Pakistan. The farm is located around 65 KM away from Karachi on National Highway (Karachi - Hyderabad). The Gharo model farm was in developing stage at the time of this study which comprised approximately 8 acres, out of which 6 acres of land was covered by sapota, and guava plants, while 2 acres of land was kept fallow for the future interest.

General Observations during Initial Survey

Topographic Conditions

During initial survey it was observed that the topographic condition of the farm was varying due to uneven slopes. The soil condition was found poor due to the less water retention, uneven slopes, and poor land leveling. A lot of extra grass and weeds were grown throughout the land as described in Figure 1.

Fig. 1. Top view of gharo model farm showing extra grass grown around the guava and sapota plots.

Fruit dropping and Size Variation

Through staff interviews it was noted that due to less water availability, low fertilizers application and lack of irrigation planning about 70 – 80 % plants of guava and sapota was suffering severely. The average height of the guava and sapota was about 4.5ft and 5ft respectively. The fruits size throughout the plantation was very small as compared to the average size. Due to nutrients deficiency sapota and guava fruits were either dropping or having small size fruits and the condition of the leaves was also very dry. Furthermore, it was observed that low amount of fertilizers were applied during fertilizers application stages due to which fruit development and maturity of fruits was suffered.

Insect pests and diseases

The survey also revealed that there was a serious attack of mealy bug on the small fruits of guava and mild attack on sapota and rodent holes were also noticed. Furthermore, in most of the guava plants termites (White ants) were also found. Leaves and branches were found infected with mealy bugs (Figure 2) and in roots portion with termites (White ants) as described in Figure 3.

Fig. 2. Mealy bug attack on Guava fruits.

Fig. 3. White ants (Termites found during pest scouting)

Irrigation

The farm was facing a serious problem of water scarcity as there was no canal water available and the only source for irrigation was groundwater. Extra grass and weeds covered all the basins and water channels (Figure 4) due to

which water distribution was very much affected and the time required to fill the basins was also exceeded.

Fig. 4. Weeds and extra grass grown in water channel and basins.

The visual look of water was found upto the mark but the taste of water was slightly saline. The water samples had been collected to conduct different water tests i.e. (pH, EC, SAR, $CaCO_3$, HCO_3 and TDS). It was observed that the region where the outlet of the bore pump was given (head of main irrigation channel) was having slight white layer on the ground surface which indicated that the water is saline in nature. Likewise, the samples of the soil were collected at 6 inch and 12 inch depth for different laboratory tests i.e. (pH, EC, nitrogen, phosphorus, potassium, and SAR). The results of the soil and water samples are given in Table 1 and Table 2 respectively.

Table 1. Analysis Results of Soil (at 6 and 12 inch depth on composite basis)

S No.	Parameters	Test Results	
		Sample 01 (Normal Zone)	Sample 02 (Saline Zone)
1	pH at 25 ^oC	9.79	8.11
2	EC	0.189 ds/m	1.86 ds/m
3	Nitrogen	79.1 kg/ha	99.34 kg/ha
4	Phosphorus	29.69 kg/ha	49.11 kg/ha
5	Potassium	349.4 kg/ha	979.18 kg/ha
6	SAR	0.418	1.39

Table 2. Analysis Results of Groundwater

S No.	Parameters	Test Results
1	pH at 25 ^oC	7.49
2	EC	3.78 ds/m
3	SAR	7.88
4	$CaCO_3$ Hardness	849.89 mg/l
5	HCO_3	313.22 mg/l
6	TDS	2534.00 mg/lit

On the basis of initial observations it had been decided by an agricultural engineers and owner that by using the available resources in the Gharo model farm the rehabilitation of the farm should to be conducted accordingly. These operations were designed to include suitable strategies for pest control, proper irrigation and fertilization of plants, removal of extra grass and weeds, and yearly farm management and recommendations plan. The execution for rehabilitation of the farm was started in the month of December 2012.

Steps for Execution of Agricultural Work

Weed and Extra Grass Removal Operation

Initially on guava and sapota plants traditional and cultural operations were performed. In the preliminary step weed and extra grass removal operation had been started. Tractor with cultivator implement had been used for the weed and extra grass removal operation. The average depth of cultivator was about 1 - 1.5 ft and the weeds and extra grass removal work had been completed in total 4 operations per acre. After the completion of operation the grass and weeds left on the land for natural sun drying. Two days later the weeds and extra grass were fully sun dried and had been cleaned (hand-picked) manually by labor.

Rough Land Levelling and Water Channelling Operation

After the cleaning operation land was leveled by a tractor with rear blade throughout the guava and sapota plots. With the objective of quick irrigation application to the plants, the water channeling operation had been done with the help of tractor and channel maker implement respectively. The basins of plants were prepared manually by local laborer accordingly.

Pesticides Application Operation

In initial survey it was noticed that guava and sapota plants were badly affected by mealy bugs and termites therefore; two operations of pesticides via spraying and flooding were applied to the plants in order to control mealy bugs and termites.

Organic Manure and Fallow Plant Basins Filling Operation

The organic matter content was found less in soil and which might have negatively affected fertility therefore; 30 - 40 kg of organic manure was given to each guava and sapota plants. The fallow basins within the plots were filled with baby plants of guava and sapota purchased from the nursery near Malir Halt, Karachi (Figure 5).

Fig. 5. Organic manure given to guava plants.

Irrigation and Fertilizer Application Operation

It was pointed out during initial survey that soil pH was slightly alkaline, and to avoid further alkalinity DAP application was immediately stopped. Nitrogen, Phosphorus and Potassium are basic constituents which may play vital role for plant development therefore; the NPK foliar fertilizer was applied to guava and sapota plants in order to provide them quick nutrients after two days of 1st pesticide application operation. While less acidic fertilizers were applied in split dozes at different fruit development stages to the plants by flooding method. The required irrigation water was applied on the basis of ET calculated from climatically parameters and proper irrigation plan had been followed throughout the research.

The ten most affected plants each from guava and sapota plots were selected and their physico-chemical properties were analyzed accordingly. The data was recorded for different agronomic parameters of plants / fruits i.e. plant height (m), number of fruit per plant, length of fruit (cm), breadth of fruit (cm), weight of fruit (g), volume of fruit (cc), number of Fruits per plant, and fruit yield (kg/Plant) respectively. Finally, the data attained during rehabilitation process was compared with the past observations available with the farm supervisor and results were calculated accordingly.

RESULTS AND DISCUSSION

The present research study was carried out to evaluate the impact of agricultural engineering practices on farm management. The outcome of the study revealed that after rehabilitation of the farm there was an improvement in the overall farming operations. The farm staff was strictly following the recommendations given by agricultural engineers and due to which overall progress of farm was improving up as compared to previous years. The collected observations and data during the research period are appended below:

Uniformity in Plantation

A uniform look among plantation has been developed due to cultural practices and land leveling operation. Due to proper water channelling time to fill the irrigation water in to the basins also decreased up to some extent. As the extra grass grown on the guava and sapota plots belonged to self growing grass family therefore it was hard to completely remove it however cultural practices were continued to overcome the grass growth. Figure 6 described the uniformity among plants before and after rehabilitation.

Fig. 6. Pictorial view of Gharo Model Farm before (left) and after (right) rehabilitation work.

Pest Control

A liquid chemical (Chlorpyrifos) with market name Lorsban 40EC was given to the plots in such way that 1 liter/acre was flooded with irrigation water to control termites and 150 ml / 100 liter of water was sprayed on the plants leaves and branches to control mealy bugs activity respectively. After the twice application of pesticides on to the plants it had been noticed that overall mealy bugs and termites appearance was 95% reduced.

Benefits of Organic Manuring

As the field was having low organic matter due to which moisture loss from the ground surface was more therefore; 30 - 40 kg of organic manure was given to each guava and sapota plants respectively. Due to manuring the water retention capacity within the soil was increased. The farm staff asked to apply organic manure to the fruit crops once in a year before the arrival of winter season as it would be beneficial for the soil and plants.

Benefits of Controlled Irrigation and Fertilization

The use of Single Super Phosphate (SSP) instead of Diammonium Phosphate (DAP) had a positive effect in controlling soil pH. Furthermore, to overcome the EC, TDS, HCO_3 and $CaCO_3$ of groundwater a large reservoir was constructed near the command area and gypsum blocks

were placed inside reservoir to control further salinity. The required irrigation water was applied on the basis of ET calculated from climatically parameters and proper irrigation plan has been followed throughout the research. It has been observed that by adopting the proper irrigation plan strategies the average water consumption from 6486 m^3/acre was reduced to 4715 m^3/acre which is 27% less than the past irrigation practices respectively.

Likewise dosage of NPK (1200:750:300) grams per plant in split doses was applied to the guava and sapota plants along with the application of 2 kg/acre of 5% zinc during flowering season. By the application of recommended doses of fertilizers the guava and sapota attained height and there was an improvement in the size of fruits as well.

It has been observed by following the prescribed dosage of fertilizers and irrigation plan the yield of guava was 33% more in the year 2013 as compared to the year 2012 (Table 3). Likewise, the sapota yield was found 41% more in the year 2013 as compared to the year 2012 (Table 4) which is remarkable gain.

Table 3. Comparison of fruit quantity parameters of guava fruit.

Fruit Crop Year	Plant Height (m)	Length of Fruit (cm)	Breadth of Fruit (cm)	Weight of Fruit (gm)	Number of fruits per plant	Fruit yield (kg / plant)
2012	2.78	6.33	5.56	87.36	323.03	28.22
2013	3.02	6.92	6.01	110.45	375.92	41.52

Table 4. Comparison of fruit quantity parameters of sapota fruit.

Fruit Crop Year	No. of fruits per plant	Length of Fruit (cm)	Breadth of Fruit (cm)	Volume of Fruit (cc)	Weight of Fruit (gm)	Pulp Weight Per Fruit (gm)	Peel Weight Per Fruit (gm)	Fruit yield (kg/plant)
2012	1212.15	3.610	4.28	70.56	86.59	68.64	16.60	109.37
2013	1506.55	4.186	5.05	112.51	120.83	97.59	22.08	189.62

CONCLUSION

The outcome of the conducted research tantamount that after rehabilitation of the farm there was an improvement in the overall farming operations as compared to previous years. Due to different agricultural operations a uniform look among plantation had been developed. The time to fill the irrigation water in to the basins also decreased. Due to effective pesticide operation the overall mealy bugs and termites appearance was 95% reduced. Due to the supplementation of organic manure the water retention capacity within the soil increased. The pH and salinity of soil and irrigation was controlled by using Single Super Phosphate (SSP) and gypsum blocks respectively. The effective irrigation plan reduced the average water consumption from 6486 m^3/acre to 4715 m^3/acre which is 33% less than the past irrigation practices. Dosage of NPK (1200:750:300) grams per plant in split doses, along with 2 kg/acre of 5% zinc increased the yield of guava and sapota up to 33% and 41%, which is an ultimate gain. Hence, on the basis of current case study it can be concluded that by adopting an effective agricultural engineering practices and following the recommendations of agricultural engineers many of the farming problems can be solved and which ultimately increases the farm yield and income.

RECOMMENDATIONS

The authors strongly recommend that government should endorse agricultural engineers to improve agricultural practices and farm management system as this profession has enormous potential to solve most of the problems facing by agriculture sector especially in developing countries.

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CONFLICT OF INTEREST

There is no conflict of interest.

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