USE OF ARTIFICIAL NEURAL NETWORKS TO STUDY ENGINEERING FACTORS FOR APPLYING DIFFERENT SOIL AMENDMENTS

By

DIIA SAID MOUNIR BOULOS

B. Sc. Agric. Sc. (Agric. Mechanization), Ain Shams University, 1998

M. Sc. Agric. Sc. (Agric. Mechanization), Ain Shams University, 2006

A thesis submitted in partial fulfillment

of

the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Agricultural Science
(Agricultural Mechanization)

Department of Agricultural Engineering
Faculty of Agriculture
Ain Shams University

2011

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Under the supervision of:

Dr. Mohamed Nabil El Awady

Prof. Emeritus of Agricultural Engineering, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University (Principal Supervisor)

Dr. Abd El Hameed Tawfeek Ahmed

Research Prof. of Soil Science, Department of Chemistry and Physical Soil, Desert Research Center

Dr. Mahmoud Zaky El Attar

Associate Prof. of Agricultural Engineering, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University

ABSTRACT

Diia Said Mounir Boulos: Use of Artificial Neural Networks to Study Engineering Factors for Applying Different Soil Amendments. Unpublished Ph. D. Thesis, Department of Agricultural Engineering, Faculty of Agriculture, Ain Shams University, 2011.

The main objective of this study is to use artificial neural network (ANN) models to predict some physico-engineering factors: bulk density, hydraulic conductivity, infiltration rate, soil penetration resistance and available water. Models also dealt with sorghum yield productivity, profit and WUE related to applying different soil amendments. The inputs for two ANN models included: Bitumen Emulsion (BE), Polyacrylamide (PAM), Organic Manure (OM), Sand (S), Silt (Si), Clay (C), Initial bulk density (IBd), Initial hydraulic conductivity (IKa), Initial infiltration rate (IIr), Initial soil penetration resistance (ISp) and Initial available water (IAW). The predicting outputs of one ANN model are: (Bd), (Ka), (Ir), (Sp) and (AW) and for a second ANN model are: productivity, profit and WUE.

Multilayer feedforward ANN was trained using a backpropagation learning algorithm. The optimal configuration for the first ANN model consisted of 3 layers (11-15-5) with sigmoid transfer function at 100,000 training runs. The optimal configuration for the second ANN model consisted of 4 layers (11-20-10-3) with hyperbolic tangent transfer function at 50,000 training runs.

During recall process, the results showed that the variation between observed and predicted outputs were very small and the correlation coefficients were 0.9850, 0.9903, 0.9946, 0.9987 and 0.9901 for Bd, Ka, Ir, Sp and AW respectively. Meanwhile, they were 0.9989, 0.9915 and 0.9856 for productivity, profit and WUE respectively.

Key Words:

Artificial neural network, soil amendments, physico-engineering factors, productivity, profit, WUE.

ACKNOWLEDGEMENT

This thesis could not have been written without the guidance of Prof. Dr. Mohamed Nabil El-Awady, Prof. Emt. of Agricultural Engineering, Ain Shams University, who not only served as my principal supervisor but also provided invaluable support, and encouragement throughout the work.

I would also like to express gratitude to Co - supervisor Prof. Dr. Abd El Hameed Tawfeek Ahmed, Prof. - Researcher of Soil Physics, Desert Research Center, for his invaluable assistance in preparing this thesis.

Appreciation is also extended to Co - supervisor Dr. Mahmoud Zaky El Attar, Associate Prof. of Agricultural Engineering, Ain Shams University, for helpful and constructive suggestions.

Thanks should be extended to the staff of Soil Physics Research Unit, Desert Research Center, for their cooperation which made this work possible.

I am indebted to my parents, my brother and Prof. Dr. Mina Kyrollos for their kind support, care and for sending me to school. And my wife, who took care of many practical details of family life, allowing me to focus on this work.

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1. INTRODUCTION

The problem of food security has the biggest concern for third world countries. The decrease in cultivated area in Egypt, is a result of population growth and urban sprawl and encroaching on farmland by concrete forests. Solution lies in reclamation of desert land, which is characterized by poor physical and engineering properties.

Soil amendments play an important role in the growth of crops. They achieve significant economic returns and suitable seed bed for germination, root growth and increased productivity. There are several types and rates of soil amendments such as Bitumen Emulsion, Polyacrylamide and Organic Manure.

On the other hand, computer applications, based on the use of disaggregated data, and knowledge deal with needed data and information about the problem to be solved. However, we must make decisions based on partial information to close this gap. Artificial intelligence and artificial neural networks, could acquire the ability to learn and solve the problems and make decisions in a way mimic to human capabilities.

Therefore, this study aims to assist and guide the farmer or the investor on how to get the fastest and most reliable predicted results as a result of the use of different types and rates of soil amendments and their impact on the engineering factors of soil to improve crop productivity, especially in newly reclaimed lands through the use of neural networks.

2. REVIEW OF LITERATURE

2.1. Feature of the brain.

The exact workings of the human brain are still a mystery. Yet, some aspects of this amazing processor are known. In particular, the most basic element of the human brain is a specific type of cell which, unlike the rest of the body, doesn't appear to regenerate. Because this type of cell is the only part of the body that is not slowly replaced, it is assumed that these cells are what provide us with our abilities to remember, think, and apply previous experiences to our every action. These cells, all 100 billion of them, are known as neurons. Each of these neurons can connect with up to 200,000 other neurons, although 1,000 to 10,000 are typical.

The power of the human mind comes from the sheer numbers of these basic components and the multiple connections between them. It also comes from genetic programming and learning.

The individual neurons are complicated. They have a myriad of parts, sub-systems, and control mechanisms. They convey information via a host of electrochemical pathways. There are over one hundred different classes of neurons, depending on the classification method used. Together these neurons and their connections form a process which is not binary, not stable, and not synchronous.

2.2. Biological neurons.

All natural neurons have the same four basic components Fig. (1). These components are known by their biological names - dendrites, soma, axon, and synapses. Dendrites are extensions of the soma which act like input channels. These input channels receive their input through the synapses of other neurons. The soma then processes these incoming signals over time. The soma then turns that processed value into an output which is sent out to other neurons through the axon and the synapses.