Abstract

Abdulwahed Mohamed Bassuni Aboukarima. ARTIFICIAL NEURAL NETWORKS CONFIGURATION FOR PREDICTING PERFORMANCE OF TILLAGE IMPLEMENTS UNDER EGYPTIAN CONDITIONS. Unpublished Doctor of Philosophy Thesis, University of Ain Shams, Faculty of Agriculture, Department of Agricultural Engineering, 2004.

The main objective of this study is to develop two artificial neural network (ANN) models to predict tillage implements performance under Egyptian conditions. However, the inputs for the two ANN models are the same, but the outputs are different. The predicting outputs of the first ANN model are effective field capacity (fed/h), fuel consumption per unit time and per unit area (liter/h and liter/fed), and plowing energy (kW.h/fed) based on fuel consumption (liter/h) and effective field capacity (fed/h). The predicting outputs of the second ANN model are draft (kN), unit draft (kN/m^2), and energy requirements (kW.h/fed) based on draft (kN), forward speed (km/h), and theoretical field capacity (fed/h). In this study, soil texture is defined using numeric values as soil texture index given by **Zein Eldin (1995)**.

Multilayer feedforward ANN (fully connected) was used in supervised manner and the training method was the backpropagation algorithm. The optimal configuration for the first and second ANN models consisted of 4 layers. The hidden layers had 12 and 24 nodes in the first and second hidden layers respectively for the first ANN model. However, for the second ANN model the hidden layers had 10 and 20 nodes in the first and second hidden layers respectively.

Hyperbolic tangent and Sigmoid transfer functions were employed in hidden and output layers for the first and second ANN

models respectively. The learning rate and the momentum parameter were 0.004762 and 0.8 respectively for the first ANN model. Meanwhile, they were 0.003146 and 0.8 respectively for the second ANN model. Iterations were 20000 and 60000 epochs during training process for the first and second ANN models respectively. During testing process, the results showed that the variation between observed and predicted outputs was small and the correlation coefficients were 0.933, 0.975, 0.952 and 0.975 for effective field capacity (fed/h), fuel consumption (liter/fed and liter/h), and plowing energy (kW.h/fed) respectively. Meanwhile, they were 0.947, 0.956 and 0.970 for draft (kN), unit draft (kN/m^2), and energy requirements (kW.h/fed) respectively.

Results showed that the inputs affect the outputs with different percentage of contribution. Forward speed was the major input affected the effective field capacity (fed/h). Meanwhile, rated tractor power was the major input affected fuel consumption per unit area (liter/fed). Also, rated tractor power and soil texture index were the major inputs affected fuel consumption per unit time (liter/h) and the major input affected plowing energy (kW.h/fed) was rated tractor power. However, the major input affects the draft (kN), unit draft (kN/m^2), and energy requirement (kW.h/fed) was rated plow width. Comparisons were made between the second ANN model and statistical equations developed using regression analysis to predict unit draft. The results showed that the second ANN model predicted unit draft with reasonable accuracy compared to statistical equations. Establishing these predictions can be considered an advantage from an economical point of view because of avoiding the need of purchasing expensive measurement instruments to collect technical data in the field of plowing or seedbed preparation process.

Key Words: Artificial neural network, ANN, Tillage implements, Prediction, Plows, Performance, regression analysis.

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List of Abbreviations

ANN	=	Artificial Neural Network
ANNs	=	Artificial Neural Networks
fed	=	Feddan
STI	=	Soil texture index
SC	=	Statistical description
EFC	=	Effective field capacity
FC	=	Fuel consumption
EE	=	Plowing energy
Avg	=	Average value
Min	=	Minimum value
Max	=	Maximum value
SD	=	Standard deviation
C.V	=	Coefficient of variation
UD	=	Unit draft
ER	=	Energy requirements
S_a	=	Sand content in soil
S_i	=	Silt content in soil
C_a	=	Clay content in soil
C	=	Chisel plow
D	=	Disc plow
M	=	Moldboard plow
R	=	Rotary plow
RTP	=	Rated tractor power
RPW	=	Rated plow width
NSP	=	No. of plow passes over the soil
PD	=	Plowing depth
FS	=	Forward speed
ISMC	=	Initial soil moisture content
ISBD	=	Initial soil bulk density
PTO	=	Power Take-Off

W_{if} = Weight between input and the first hidden layers

W_{fs} = Weight between the first and the second hidden layers

W_{so} = Weight between the second hidden and output layers