FertiSolver

An excel based fertilizer dose calculator

Software User Manual

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Contents

Platform Requirements

For Windows

Computer and processor	1 gigahertz (GHz) or faster x86- or x64-bit processor with SSE2 instruction set
Memory (RAM)	1 GB RAM (32 bit); 2 GB RAM (64 bit)
Hard Disk	3 GB available
Display	Graphics hardware acceleration requires a DirectX10 graphics card and 1024 x 576 resolution
Operating system	Windows 10 or Windows 8.x; Windows Server 2012
Browser	Firefox 10.x or later; Safari 5; Chrome 17.x

Mac OS X

Computer and processor	1 gigahertz (GHz) or faster x86- or x64-bit processor with SSE2 instruction set
Memory (RAM)	1 GB or more of RAM
Hard Disk	2.5 GB of available hard disk space
Display	1280 x 800 or higher resolution monitor
Operating system	OS X version 10.5.8 or later
Browser	Safari 5 or later (recommended)

Installation

The FertiSolver does not require any special installation procedures. Users can copy and paste the .xlsx file on the hard drive and start using it. While opening the file for the first time following security warning may flash. Users are required to click on “Enable Content” to proceed further.

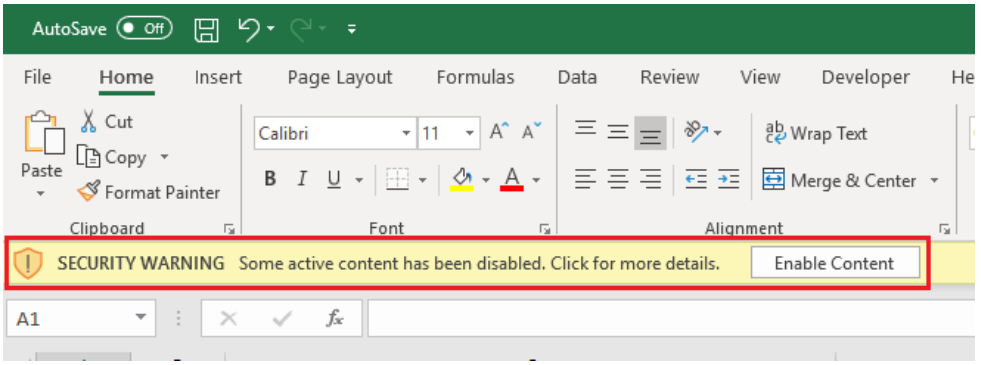

Fig.1 Enabling the macros in MS Excel on first use

FertiSolver Updates and Availability

For updates of this tool and versions, please visit www.icarrcer.in or Contact the developers at:

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Institution
ICAR-Research Complex for Eastern Region, Patna. 800 014

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Evaluation of leaching loss of nutrients in acidic soils of Jharkhand under different cropping systems, Grant No.: ICAR-RCER/ RC Ranchi/2011/ 196

Introduction

Fertilizers are an inevitable factor in improving soil fertility and productivity of crops regardless of the nature of cropping sequence or environmental conditions. It has been unequivocally demonstrated that one-third of crop productivity is dictated by fertilizers besides influencing use efficiencies of other agri-inputs. Agriculture in developing countries including India is facing a problem of low organic matter, imbalanced fertilization, and low fertilizer response that eventually caused crop yield stagnation. In order to achieve a target of 300 million tons of food grains and to feed the burgeoning population of 1.4 billion in the year 2025, the country will require 45 Mt of nutrients as against a current consumption level of 23 Mt. The extent of multi-nutrient deficiencies is alarmingly increasing year by year which is closely associated with a crop loss of nearly 25–30 %. The N: P: K use ratio has been skewed by sub-optimal nutrient use of 4:2:1 (N: P_2O_5:K_2O) and needs to be restored urgently. Balanced and judicious use of fertilizers is the key to efficient nutrient use and for maintaining soil productivity.

Site specific nutrient management involving soil test based application of fertilizers is critical to enhance fertilizer use efficiency. However, blanket fertilizer recommendations are generally followed which rarely matches soil fertility need. Government of India is promoting integrated nutrient management (INM) i.e. balanced and judicious use of chemical fertilizers, along with bio fertilizers and locally available organic manures based on soil testing to maintain soil health and crop productivity. With increasing laboratories and awareness among farmers, soil testing is becoming a routine practice. Adjustment of recommended doses of fertilizers in accordance with the soil test reports is still a challenge. The 'FertiSolver' tool has been developed to address these challenges and help the farmers in achieving higher productivities with reduced cost on fertilizer through balanced and optimal doses of fertilizers.

About FertiSolver

Precise site and crop specific fertilizer recommendations are more scientific as compared to blanket fertilizer recommendations. Application of recommended doses sometimes lead to excessive loss of fertilizers with reduced nutrient use efficiency and land productivity. Many countries are shifting to precision farming with field level nutrient management alternatives. This is further supplemented with soil test reports to work out accurate nutrient requirements. Instead of applying a recommended dose of fertilizers, the focus in now on adjusting the recommended dose based on soil test reports. Assessment of accurate nutrient requirements and associated fertilizer dose is a key challenge faced by the farmers and local extension agencies. The complex nature of factors influencing nutrient requirements complicates the process of determining appropriate fertilizer doses. The nutrient requirement of plants, nutrient availability in soil and the varying percentage of active ingredients in the complex wide range of complex fertilizers leads to intricate procedures.

Fig.2 The start Screen of FertiSolver

FertiSolver is a completely offline soil test-based fertilizer recommender tool for desktop computers. The tool provides calculations according to the area of farm and type of crop using the principles of site-specific nutrient management. The FertiSolver has the capability to work out fertilizer requirements by comparing the recommended dose of fertilizers and the soil test reports. It has inbuilt database on recommended dose of fertilizers for major crops of Eastern Plateau and Hill Region (EPHR) of India.

Overview

FertiSolver is a decision support software for PCs with windows and MAC platforms enabling farmers and local experts to quickly work out the fertilizer recommendations for the major crops of EPHR. The tool will help farmers in increasing their yields and net returns by providing an optimal fertilizer management strategy based on soil test reports. Inputs required in the tool can be easily provided by the user. Extent of area, type of crop and soil testing report (if available) are the main inputs to the tool. The user also gets a wide range of fertilizers to select from the drop down menus. The FertiSolver generates a detailed report on quantity of selected fertilizer required for the selected crop and area combination. The tool also presents a cost to incurred on the choice of fertilizers. In addition, the FertiSolver is designed in such a way that users can go back and change the choice of fertilizers and assess the impact changed fertilizers sources on total cost of fertilizers. So this software acts as a learning tool—providing different combinations of fertilizers, instant summary tables and cost of fertilization – allowing a great amount of flexibility in navigating through the modules in the tool.

The development of FertiSolver was developed with following goals:

- Optimizing the amounts of fertilizer Nitrogen (N), Phosphorous (P), potassium (K), and other micro-nutrients to minimize nutrient losses.
- Estimate required fertilizer NPK rates based on crop-specific fertilizer recommendations and soil test reports.

- Translate nutrient rates into fertilizer requirements.
- Minimize depletion of soil fertility.
- Achieve high yields, profitability in the short and medium term.

Assumptions and Conditions

The FertiSolver is based on certain assumptions

- The crop is supplied with required amount of water and that there is no serious limitation on soil moisture that can affect the nutrient uptake by crops.
- Standard crop-specific fertilizer application times are followed by the farmers.
- Any problem on soil acidity/salinity or any other restricts that can hamper nutrient uptake are properly addressed.
- All the selected fertilizers are available in the market.
- Fertilizer prices considered in the FertiSolver are average market prices for the year 2021.

The Do's and Don'ts with FertiSolver

1. Do enter the data in proper units of measurement. For example, the area is in decimal. Convert your original data in the units desired by the FertiSolver.
2. Follow the proper sequence of the operations as indicated by the forward arrows at the bottom of each screen.
3. Do not copy and paste data in to cells.
4. Always enter data using keyboard.
5. Do not alter the cell values other than specified cells for data input.
6. The cells for inputting the user data are marked in light blue background.
7. Do not delete any Excel sheet within the FertiSolver.
8. In case you deleted a sheet or cell formulae by mistake, do download a fresh version from the specified webpage.

The Model Architecture

The FertiSolver has four modules. First module checks if the user has a soil test report. If user selects an option 'Yes' then the tool asks for the soil test report data. Second module is about selecting crop types and entering crop related data. The third module provides choices on sources of N, P, K, Zn, B and S fertilizers. The fourth module deals with production of reports pertaining to recommended fertilizers quantities and the costs thereof. The general flow of information and step-by-step procedure used in the model architecture is presented in Fig.3.

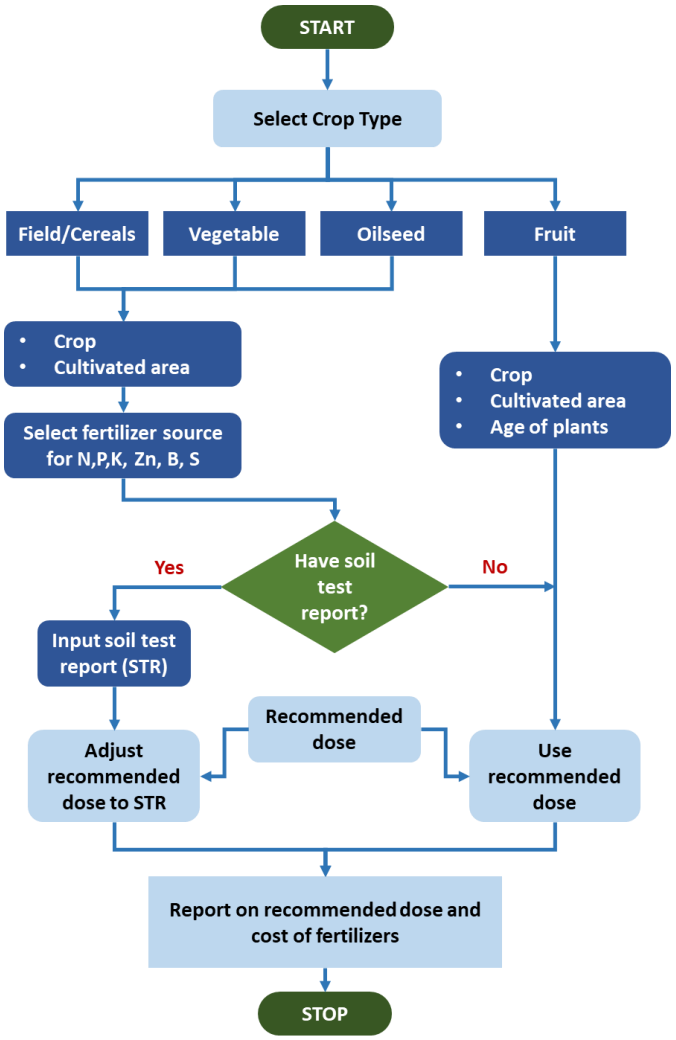


Fig.3 The model architecture

Steps in Using and Navigating FertiSolver

This section explains the step by step procedure to work with FertiSolver to get the best recommendations for the selected crop and area combination.

Soil test report module

Soil test report module is for entering the soil test report data. The first screen, after opening screen of the FertiSolver, is to check whether user has a soil test report (Fig. 4). There are two options, if user selects 'Yes', the next screen asks for the soil test repot otherwise 'Select Crop Type' screen appears. The farmers/users can get their soil samples tested from an authentic soil test laboratory. The goal of soil testing is to help farmers achieve economical optimum yields while protecting the environment. Nutrient contents are precisely determined for the soil/plot under consideration and the fertilizer requirements of crops are determined keeping in view these present levels of nutrients in soils. User has to enter the present levels of nutriment contents as determined using soil test reports in the 'Soil Test Report Module'. Current version of FertiSolver requires soil test results on Nitrogen (N), Phosphorous (P), Potassium (K), Zink (Zn), Boron (B) and Soil pH.

After entering the soil test data, click NEXT at the bottom of the screen. This will open a screen for making choice of fertilizers sources for different nutrients. As the user enters a particular value in the input cell the tool highlights the level of nutrient availability as 'Low', 'Medium' or 'High'. In case of pH, the levels are indicated in terms of 'Acidic', 'Normal' or 'Basic' (Table 1).

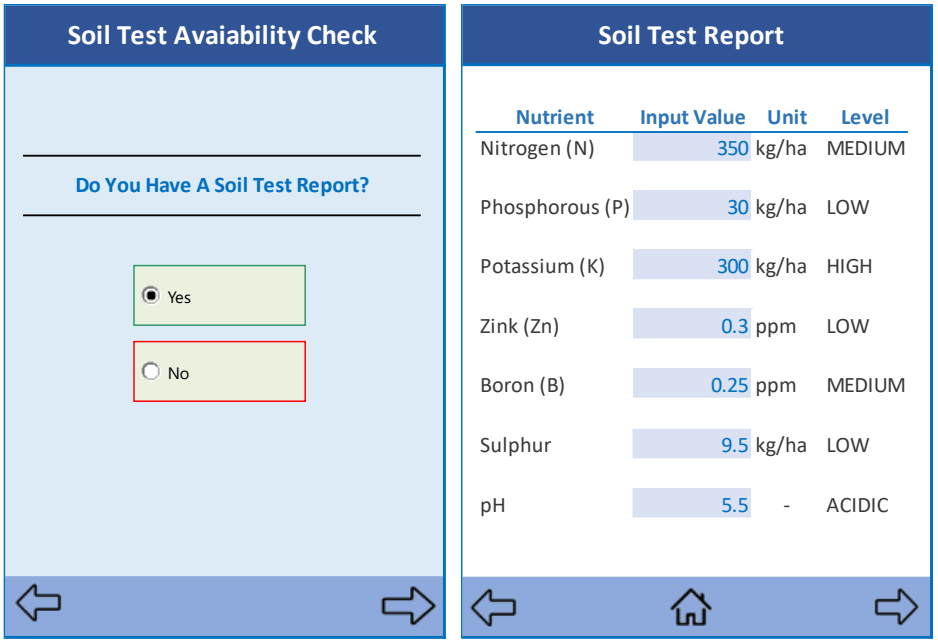


Fig. 4 The soil test report entry screen

Table: 1 Categorization of nutrient status

Nutrient	Low	Medium	High
Nitrogen (N), kg/ha	<282	282-560	>560
Phosphorous (P), kg/ha	<34	34-68	>68
Potassium (K), kg/ha	<108	108-280	>280
Zink (Zn), ppm	<0.6	0.6-1.0	>1.0
Boron (B), ppm	<0.25	0.25-0.5	>0.5
	Acidic	Normal	Basic
pH	<6.5	6.5-7.5	>7.5

The crop choice and crop data module

FertiSolver has the inbuilt database of 49 crops. These crops are categorised in to four different categories as field crops, vegetable crops, oilseed crops and fruit crops. This is just to facilitate the user in making quick choices rather than scrolling through the wide range of crops in the dropdown menus. The list of crops included in each category are provided below (Table 2).

Table 2: Details of crop categories and crops considered in FertiSolver

Field crops	Vegetable crops	Oilseed crops	Fruit crops
Arhar	Cabbage	Linseed irrigated	Mango
Black gram	Cauliflower	Linseed unirrigated	Litchi
Chick pea	Brinjal	Mustard	Sapota
Cow pea	Chilli	Soybean	Guava
Field pea	Capsicum	Groundnuts	Aonla
Green gram	Tomato	Til	Orange
Lentil	Okra	Niger (Surguja)	Ber
Maize	French bean	Sunflower	Peach
Millet	Carrot		Cashew
Rice bean	Radish		
Rice-Lowland	Cucumber		
Rice-Midland	Ridge gourd		
Rice-Upland	Pointed gourd		
Wheat-Irrigated	Bottle gourd		
Wheat-unirrigated	Bitter Gourd		
	Potato		
	Onion		

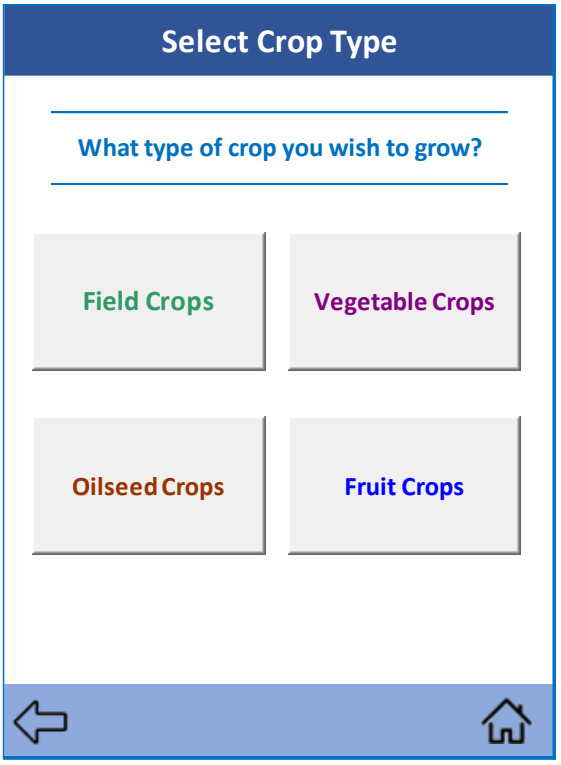


Fig. 5 The crop type selection screen

As the user clicks on any of the four options (buttons), the respective crop data screen opens. Note that there is no need to click on next button here. The next screen opens automatically.

Upon selecting the crop type one of the following screens will appear depending on the choice of user. On this screen user inputs the data regarding the crop choice and plot size. In case of 'fruit crops' user needs to enter an additional input regarding the age of the plants. The data input screens for four types of crops are shown in Fig. 6. Keeping in view the wider use of 'Decimal' as local unit of land area measurement, the tool takes-in the land area in decimal units. The tool then converts the decimal to hectare for its internal computations.

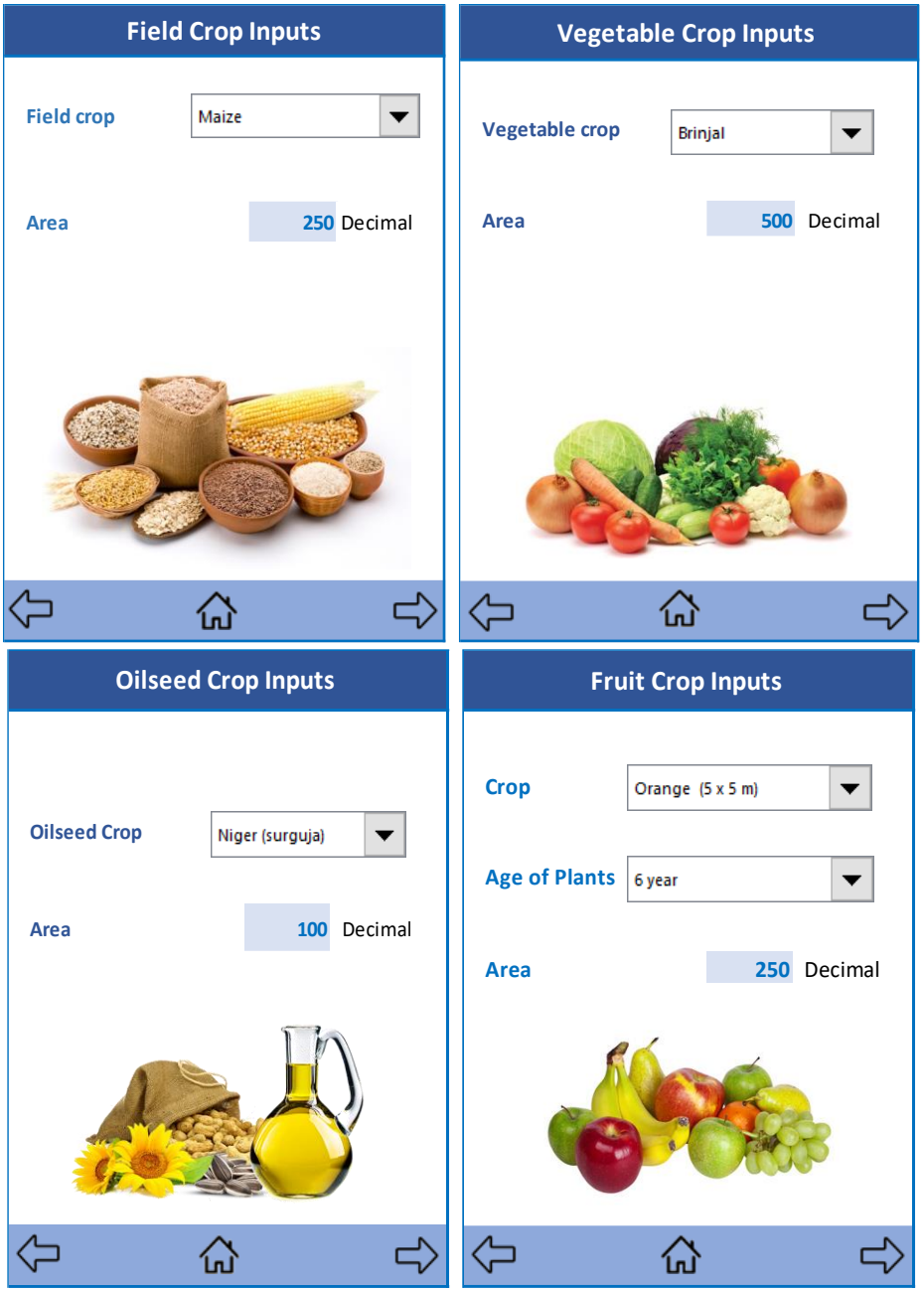


Fig. 6 The data input screens for Field, Vegetable, Oilseed and Fruit crops

When all the data are inputted, click 'NEXT'. This opens a screen for selection of fertilizer sources.

Fertilizer source module

There are multiple sources of fertilizers for particular nutrient. Choice of the fertilizer for which is governed by the cost and its availability in local market. The 'Fertilizer Source Module' offers the choice of fertilizers to the users. Users can try different combinations of fertilizers for different nutrients and works out the total cost of fertilizing a given crop. Fertilizer sources considered in FertiSolver for different nutrients are as follows:

Table 3: Sources of fertilizers considered in FertiSolver

Fertilizer type	Fertilizer Source
Complex fertilisers (NPK)	• Diammonium Phosphate - 18:46:0 • 12:32:16 • 14:35:14 • Single Super Phosphate- 0:16:0
Nitrogenous fertilizers	• Urea- 46:0:0
Potassic fertilisers	• Murate of Potassium-0:0:60 • Sulphate of Potash-0:0:50
Zink fertilizers	• Zinc Sulphate - 21 % • Zinc EDTA - 12%
Boron fertilizers	• Borax - 10.5 % • Solubore - 19% • Boron - 20
Sulphur Fertilizers	• Elemental Sulphur • Ammonium Sulphate

In case of fruit crops, the FertiSolver uses a standard sources of fertilizers and therefore it does not offer fertilizer choices. If user has selected the 'fruit crops' option, there is no need to enter the fertilizer sources. Here, after entering required crop and area parameters the FertiSolver directly provides the recommendation based on crop, cropped area and the age of fruit plants.

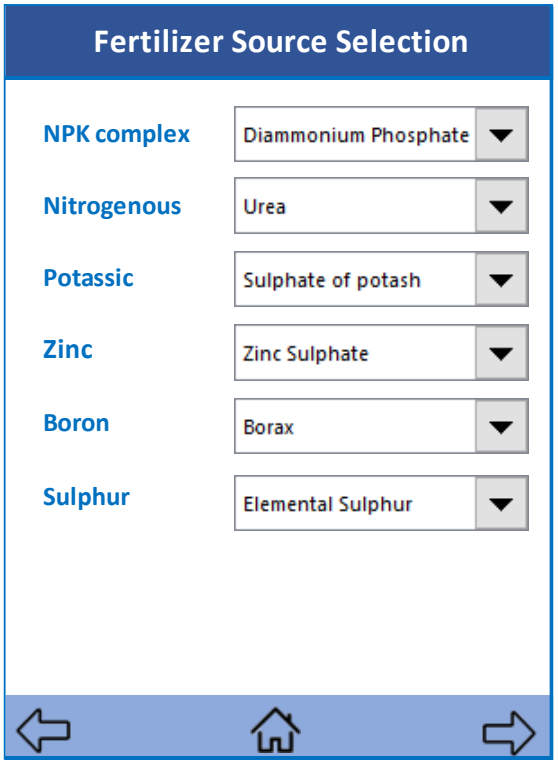
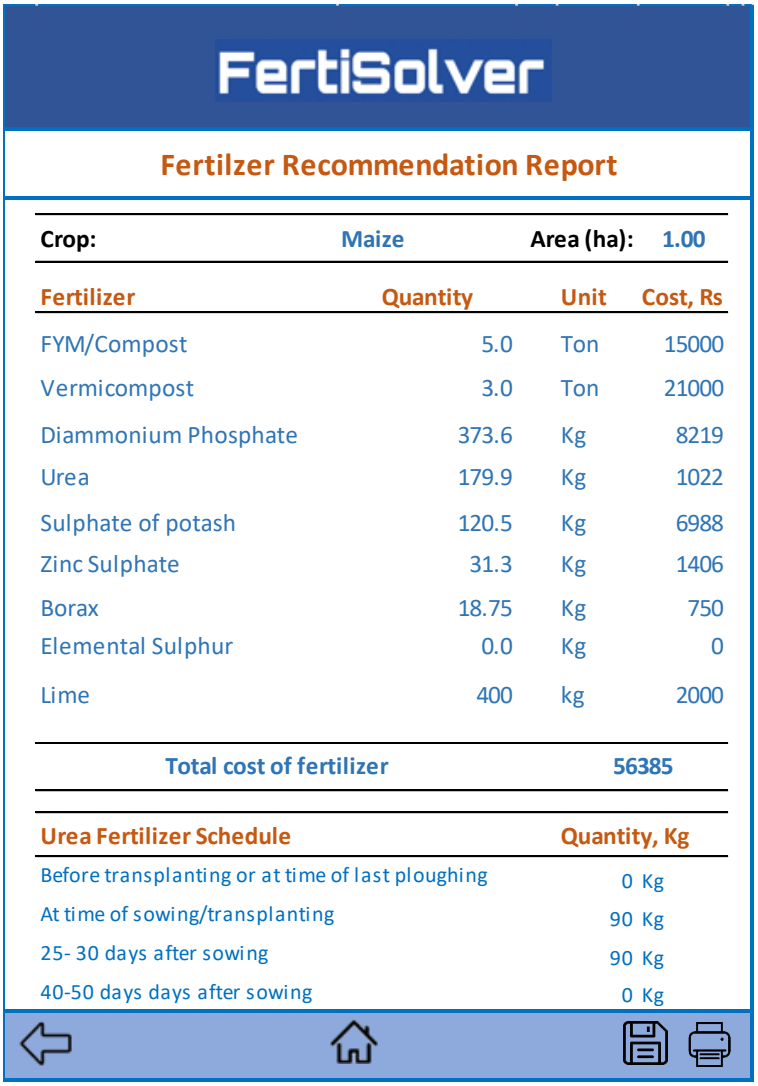


Fig.6 Selection of fertilizer source for different nutrients

The output module

This is a 'Fertilizer Recommendation' page wherein the final output from the FertiSolver is presented. The tool works out the requirement of each selected fertilizer based on the recommended dose of fertilizer for each crop or after adjusting the recommended dose of nutrients in accordance with soil test report. The tool has inbuilt mechanism to adjust the fertilizer requirements as per the percentage of active ingredients of nutrients in each of the selected fertilizer. In case of field crops, vegetable crops and oilseed crops the FertiSolver also provides information on number of splits of urea fertilizer. It provides users with optimal time and dose of urea application for the selected crop. The output screen for these three types of crops is shown in Fig. 7.



FertiSolver

Fertilzer Recommendation Report

Crop:	Maize	Area (ha):	1.00

Fertilizer	Quantity	Unit	Cost, Rs
FYM/Compost	5.0	Ton	15000
Vermicompost	3.0	Ton	21000
Diammonium Phosphate	373.6	Kg	8219
Urea	179.9	Kg	1022
Sulphate of potash	120.5	Kg	6988
Zinc Sulphate	31.3	Kg	1406
Borax	18.75	Kg	750
Elemental Sulphur	0.0	Kg	0
Lime	400	kg	2000
Total cost of fertilizer			56385

Urea Fertilizer Schedule	Quantity, Kg
Before transplanting or at time of last ploughing	0 Kg
At time of sowing/transplanting	90 Kg
25- 30 days after sowing	90 Kg
40-50 days days after sowing	0 Kg

Fig. 7 The output screen for field, vegetable and oilseed crops

The output screen for the fruit crops is slightly different (Fig. 8). Instead of providing split doses of urea, it displays the 'Fertilizer application guidelines' as per the age of the plants. It provides recommendation on place of application of fertilizer, depth of application and the general timelines for fertilizer application. The crop age of 'Planting' refers to the time of transplanting of saplings in the pits. At this stage the FertiSolver provided details on pit sizes and the fertilizer mix that has to be incorporated in the back filled soil.

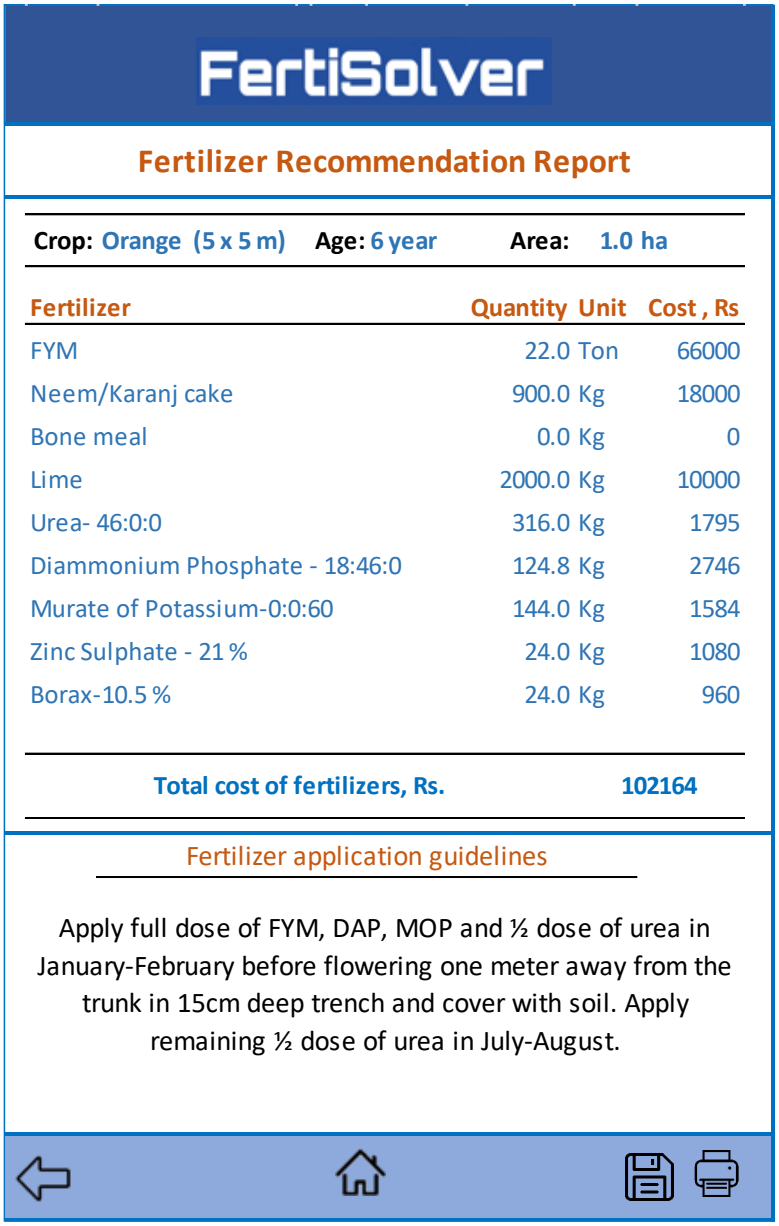


Fig.8 The output screen for fruit crops

In all the crop types, FertiSolver computes the cost of each fertilizer for the selected crop-area combinations considering the average prices of fertilizers for the year 2021. Users have the flexibility to go back to the fertilizer source selection page and try different combination to check whether the cost can further be reduced.

Printing and saving the FertiSolver output

Once the user has finalised the report, the same can be saved in .pdf format for future use. The output screen has the save output button at the bottom of the output screen (Fig. 9). The filename and path has to be specified in the dialog box that opens after clicking save button. Users also gets the option to print the output using print command button provided at the bottom of the output screen (Fig. 9).

Fig. 9 Printing and saving the FertiSolver output

Appendices

Appendix-A: Recommended dose of nutrients

Recommended dose of fertilizers and percentage of split doses for total urea

Crop	FYM t/ha	Vermi Compost, t/ha	Nutrient				Split doses for Urea application (%)			
			N	P	K	S	T1	T2	T3	T4
Arhar	3-5	2-3	25	50	25	0	0	100	0	0
Black gram	3-5	2-3	25	50	25	0	0	100	0	0
Chick pea	3-5	2-3	25	50	25	0	0	100	0	0
Cow pea	3-5	2-3	20	40	20	0	50	0	50	0
Field pea	3-5	2-3	25	50	25	0	50	0	50	0
Green gram	3-5	2-3	20	50	25	0	0	100	0	0
Lentil	3-5	2-3	25	50	25	0	0	100	0	0
Linseed irrigated	3-5	2-3	50	30	20	20	0	50	50	0
Linseed unirrigated	3-5	2-3	30	20	20	20	0	50	50	0
Maize	5-10	3-5	120	60	40	0	0	50	50	0
Millet	5-10	3-5	40	30	20	0	0	50	50	0
Mustard	3-5	3-5	50	25	25	20	0	50	50	0
Rice bean	3-5	3-5	20	40	20	0	0	100	0	0
Rice-Lowland	5-10	3-5	120	60	40	0	0	50	25	25
Rice-Midland	5-10	3-5	80	40	20	0	0	50	25	25
Rice-Upland	5-10	3-5	40	20	20	0	0	50	25	25
Wheat-Irrigated	5-10	3-5	120	60	40	0	0	50	25	25
Wheat-unirrigated	5-10	3-5	60	30	20	0	0	50	50	0
Cabbage	20-25	5 -7	200	35	50	0	0	50	25	25
Cauliflower	20-25	5 -7	150	26	50	0	0	50	25	25
Brinjal	20-25	5 - 7	120	26	50	0	34	0	33	33
Chilli	20-25	5 -7	60	22	42	0	34	0	33	33

Capsicum	20-25	5 -7	60	44	42	0	34	0	33	33
Tomato	20-25	5 -7	120	26	50	0	34	0	33	33
Okra	20-25	5 -7	120	35	50	0	0	50	50	0
French bean	20-25	5 -7	60	22	42	0	50	0	50	0
Carrot	20-25	5 -7	60	22	62	0	0	50	0	50
Radish	20-25	5 -7	80	26	50	0	0	50	50	0
Cucumber	20-25	5 -7	50	17	33	0	0	50	50	0
Ridge gourd	20-25	5 -7	50	26	42	0	50	0	50	0
Pointed gourd	20-25	5 -7	120	26	42	0	34	0	33	33
Bottle gourd	20-25	5 -7	50	26	42	0	0	50	50	0
Bitter Gourd	20-25	5 -7	50	26	42	0	0	50	50	0
Potato	20-25	5 -7	125	39	75	0	0	50	50	0
Onion	20-25	5-7	80	26	66	0	0	50	50	0
Soybean	3-5	2-3	25	50	20	40	0	100	0	0
Groundnuts	3-5	2-3	25	50	20	40	0	100	0	0
Til	3-5	2-3	40	20	20	0	0	50	50	0
Niger (surguja)	3-5	2-3	20	20	20	0	0	100	0	0
Sunflower	3-5	2-3	40	50	25	25	0	100	0	0

*On the basis of published research, the recommended concentration of Zn and B was considered as 5.25 and 1.575 ppm. T1=Before transplanting or at time of last ploughing, T2=At time of sowing/transplanting, T3=25- 30 days after sowing, T4=40-50 days after sowing

Appendix-B: Cost of fertilizers

Cost of fertilizers considered in the tool

Fertilizer	Price, Rs/kg
Diammonium Phosphate - 18:46:0	22.00
Complex 12:32:16	23.00
Complex 14:35:14	23.30
Single Super Phosphate- 0:16:0	8.56
Urea- 46:0:0	5.68
Murate of Potassium-0:0:60	11.00
Sulphate of potash-0:0:50	58.00
Zinc Sulphate - 21 %	45.00
Zinc EDTA - 12%	500.00
Borax-10.5 %	40.00
Solubore - 19%	100.00
Boron 20	100.00

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