K Manikandan
Agricultural College and
Research Institute, Killikulam,
Thoothukudi, Tamil Nadu, India

Rajeev Sharma
Directorate of Mushroom
Research Chambaghat, Solan,
Himachal Pradesh, India

OP Ahlawat
Directorate of Mushroom
Research Chambaghat, Solan,
Himachal Pradesh, India

Nitrogen calculator: A decision support tool for compost production of white button mushroom

K Manikandan, Rajeev Sharma and OP Ahlawat

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Abstract
White button mushroom is most favoured mushroom both in India and world. It is revered for one of the option to meet the growing vegetable demands of India as mushroom cultivation do not require additional land. The productivity of white button mushroom mainly depends on the quality of compost. Button mushroom compost is prepared from wide variety of substances and accordingly the nutrient content and quality varies widely. Mushroom growers facing difficulty in choosing ingredients for producing quality compost besides lacking understanding on proportion of different ingredients for making compost. This paper illustrates about the decision support tool for making ideal compost for button mushroom compost.

Keywords: White button mushroom, compost, ICT, DSS, mushroom growers utility

Introduction
Button mushroom is the most popular mushroom both India as well as world. The production and productivity of button mushroom is governed by multitude of factors *viz*., compost, strain, spawn, substrate, environmental conditions and irrigation. Kind of substrate and its quality parameters is the prominent among all over which productivity of mushroom stands (Vijay., *et al*., 2012) [20]. The substrate for button mushroom is referred as compost, which is prepared from wide range of agricultural residues but principally of wheat straw (Verma and Vijay, 2002) [18].

Compost for button mushroom can be prepared in many ways using both organic and inorganic substances (Mahantesh *et al.,* 2018) [17]. Wheat straw, chicken manure, wheat bran is the most widely used ingredient for button mushroom compost production. The nutrient content of these materials varies widely depending upon the source (Bech and Riber, 1967) [4].

Input raw materials are the prominent factor in determining the compost composition. Significant positive relationships obtained between nitrogen content of compost and mushroom yield (Ahlawat and Vijay, 2011) [1]. Atkins (1963) [2] stated that a correlation between nitrogen per cent, dry matter and yield, significantly at 2% level. Lambert and Ayer (1950) [9] found that yields were significantly increased when compost was supplemented with protein rich materials. Ratios of carbon and nitrogen outside the optimum range cause substantial reduction in yield (Pathak *et al.,* 2017) [14]. Minimal nitrogen content of the initial compost formulation must be of 1.6 (Manikandan., *et al.,* 2013) [10].

Wide variety of agricultural residues are utilized for preparing compost for button mushroom production (Viaji, 2010) [19]. The nutrient content as well as compost quality differs accordingly which in turn results in varying yield. Compost rich in nitrogen derived from organic source is more productive than the compost produced from inorganic sources (Manikandan., *et al.,* 2013) [12]. Mushroom growers do not aware about the nutrient content of different input materials and less knowledge on chemical changes occurs during composting process.

The application of ICT tools is well known in many spheres. ICT tools have the potential to deliver the information to the needy people in desired form in time. The accessed information can be exploited for developing useful utilities by the users after proper assessment. ICT essentially facilitate the creation, management, storage, retrieval, and dissemination of any relevant data, knowledge, and information that may have been already been processed and adapted (Batchelor 2002; Chapman and Slaymaker 2002; Rao 2007) [3, 5, 14].

Corresponding Author:
K Manikandan
Agricultural College and
Research Institute, Killikulam,
Thoothukudi, Tamil Nadu, India

The advantages of ICT tools and techniques are widely utilised in service sectors but it's recognition in agriculture is of recent origin. The main reasons for the lesser use of ICT in agriculture sector are absence of accessible as well as appropriate data, improper dissemination of information, unwillingness to adopt new technology, need for farmer specific utility in regional language, sustainability, affordability, ease of use, accessibility etc. (Keniston 2002; Dossani *et al.,* 2005; Saravanan 2010) [8, 6, 15]. Hence, the potential of ICT application and its integration in different agriculture sectors is underutilised and much scope is yet to be identified and harvested.

Web based expert system for mushroom developed by Directorate of Mushroom Research in association with Indian Agricultural Statistical Research Institute which caters basic needs of mushroom growers (Gautam, 2012) [7]. Manikandan and Rajeev (2013) [11] developed a mushroom database of India in VB.net platform for ease retrieval of wild mushroom information. But there is no supporting tool for farmers in predicting compost N content and quality while using different crop residues from the farm.

Considering knowledge gap in compost formulation using different residues and advantage of ICT tools, a decision support tool using ICT is attempted to support the mushroom growers in formulating the compost with different crop residues available in their farm.

Materials and Methods
This tool is devised as a PC based module and incrementing prototyping model was followed to develop different standalone applications. This module is developed using VB.net platform.

Six mushrooms *viz.,* button, paddy straw, oyster, milky, shitatake and reishi mushrooms are considered for this application. One open end option is also given to choose wide variety of substances.

Input option demands four data such as name, weight, N content and moisture content of each ingredient. As farmers, lack knowledge on nutrient content of each ingredient, the general nutrient status of ingredient will be displayed in the respective input entry in light transparent display mode. In case farmers, tested the sample and having test results of N content, they can input the exact N value.

Initially, application process the actual dry matter content of the total compost formulation. It is worked out by adopting following formulae considering the moisture content of each input.

$$DMC = \sum_{i=1}^{n}(W_1 \; x \; M_1) + \cdots + (W_n x M_n)$$

where, DMC - dry matter content of compost formulation; Wn is the weight of input-n and Mn - is the moisture content of the input n, n is the number of inputs included in the compost formulation.

In the next step, total nitrogen content of the compost formulation is arrived by adopting the following formulae;

$$Total \; N = \sum_{i=1}^{n}(W_1 \; x \; N_1) + \cdots + (W_n \; x N_n)$$

Where, Wn is the weight of input-n and Nn - is the nitrogen content of the input-n, n is the number of inputs included in the compost formulation.

In the third stage, N content of the compost is attained based on the total dry matter content and total N content of compost formulation.

$$Nitrogen \; content \; (\%) = \frac{Total \; N \; in \; the \; compost \; formulation \; (kg)}{Total \; dry \; matter \; content \; of \; compost \; formulation \; (kg)} \; x \; 100$$
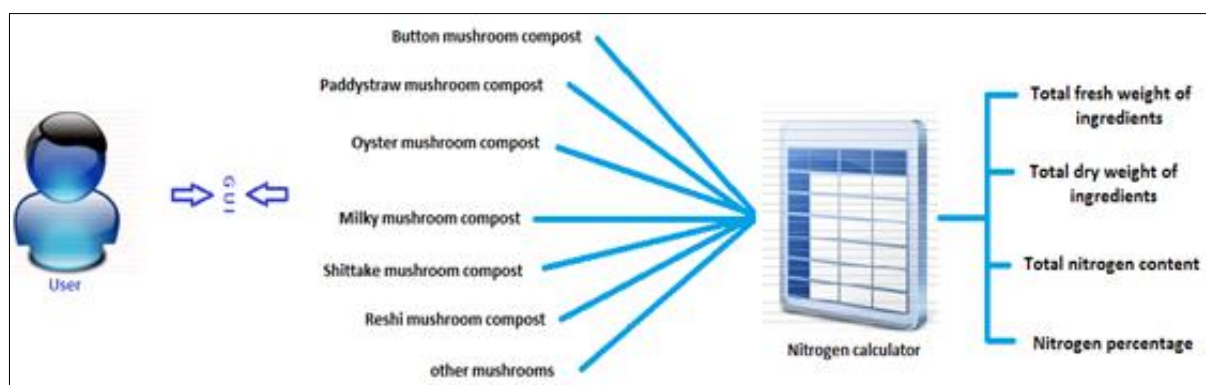

Fig 1: Design of Nitrogen Calculator for compost formulation

The front end of the user input form is designed for ease understanding for all users. The results of the N content is correlated and advisory given to users.

Result and Discussion
This module aids mushroom growers in determining the nitrogen content in composts which is considered as critical factor for compost production for white button mushroom. This application requires information on input name, quantity utilized, moisture content and N content of each input used for compost preparation.

This module facilitates free choice of input by the mushroom growers according to the local availability of agricultural residues. On inputting essential data, user will get the N content of the compost formulation immediately along with necessary advice.

Nitrogen content of the initial compost formulation should not be less than 1.6% (Vijai, 2010) [19] towards obtaining optimum mushroom yield. Further, the inorganic input for nitrogen should be less than 2% compared to the overall formulation. Higher proportion of inorganic N reduces the mushroom yield as it produces more ammonia which is less preferable to mushroom. Accordingly, initial nitrogen content and proportion of inorganic N source are considered for generating advisory for the mushroom growers towards compost quality information.

User will get ideal composition results if the N content is more than 1.6 at the time of beginning. In case of compost N content less than 1.6, farmers will get a advisory stating N

content of the compost formulation is less. In this case, mushroom grower need to add more N source preferably organic sources to increase the N content of the compost. Lesser N content decreases the N content of the compost and lengthen the composting schedule besides reducing the compost quality.

Application of higher inorganic N in the compost formulation produces more of ammonia. Ammonia is hazardous to fungi and hence, restricts the growth of *Agaricus bisporous*. This module primarily helps the farmer to adjust the N supplements in such a way that compost formulation should contain appropriate N content in compost. In addition, it helps the farmer in selecting ideal alternate materials for compost preparation besides guiding the proportion to be incorporated in compost formulation.

Fig 2: User interface for input entry

Fig 3: Results on N calculation

Conclusion
The use of ICT tools and its advantages are widely recognized in agriculture sector. Accordingly, in recent times, ICT application in agriculture is rapidly expanding in different spheres. This helps the delivery of needy and desired information to the farmers in shortest possible time besides ensuring accessibility of information by different users. In this line, farmer friendly utility modules for mushroom growers such as mushroom information system, profit calculator, compost N calculator, weather database and Indian wild mushroom database were developed. These applications will provide a platform towards implementation of ICT in mushroom field and will help mushroom growers, purchasers

and experts to work together for the overall development of mushroom industry.

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