Chapter 1  Introduction

1.1 A Holistic Overview of the Work

In the present day ICT application is a widely used technique for mass dissemination of research outcomes. It is also environment friendly since it saves papers and thus saves the nature. Young generation is also very fond of electronic gadgets and use of internet. Application of Information Communication Technology (ICT) in any sector definitely boost-up its performance. Agriculture sector is not an exception to it. Higher the use of ICT in agriculture, the higher will be the outreach activities. Now, agriculture in India has its focus on production as well as on market of the produce where farmers should grow depending on the market price. In order to predict the market price of any agricultural produce we need to know the market trend. But, the fluctuation in market price due to season prevents the farmers to get the maximum profit out of their produce. To predict the market price, exponential smoothing has been proven to be very useful technique in many forecasting situations. It was first suggested by Holt (1957) and was meant to be used for non-seasonal time series data (Chatfield, 2013). Later, Winters (1960) generalized the method to include seasonality, hence the name "Holt-Winters Method" (Gelper et al., 2010; Bermudez et al., 2010). Application of the Holt-Winters Method for predicting price of a produce will not be an easy task for a farmer. A user friendly Expert-System for predicting the market trend might be a very useful tool for the farmers who can themselves predict the market price in advance using the Expert-System. Therefore, a study had been undertaken to develop a user friendly Expert-System that can forecast market trend in green chilli using Holt-Winters method.
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Climate-smart agriculture is defined as an approach for transforming and reorienting agricultural development under the new realities of climate change (Lipper et al. 2014). Climate Change depends on many factors, among which soil pollution is one of the important causes. There are many other factors of soil pollution, among which improper dose and excess dose of fertilizer application are two major issues. The Govt. of India has taken initiative for Soil Health Card for every farmer of the country, in order to know the soil characters and to prevent extra use of fertilizer and thus to prevent soil pollution. But the ground reality is that, the required human resource in Soil Testing Lab is less in compared to need. On other side Binary fertilizers and mixed fertilizers have various ratios of Nitrogen, Phosphorus or Potassium composition and fertilizer requirement calculation for a particular size of land undergoes a complex method. It becomes difficult to calculate various possible combinations of straight and binary fertilizers within a short period of time. Thus is the necessity of an Expert-System is felt, which will not only calculate the deficiency of soil nutrients but will also suggest the best combination of fertilizer dose among those which are available in the market. Regarding soil pH correction, most of the soil related books or articles have readymade table which tells about the amount of CaCO₃ required to increase pH to a particular point, i.e 6.5 or 7.0. The flexibility to increase or to decrease the pH value between any two points is required. Also we need to calculate equivalent amount of CaCO₃ or Ca(OH)₂, CaMg(CO₃)₂, CaO, CaSiO₃, CaSO₄·2H₂O, S, FeS₂, FeSO₄·7H₂O, CaS₅ every time. This calculation can also be facilitated with the help of this Expert-System. General convention of Agriculture follows the calculation of Liming material, Sulphurous material or fertilizers in Ton (or Kg) per Hectare. But most of the Indian farmers have small or marginal land holdings and this involves another calculation to convert Hectare to other smaller units. This software includes all common units like Hectare, Acre, Bigha,


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Katha, Decimal, Sq. meter or Sq. feet and thus conversion of unit become easy. Micro nutrient is an important aspect for maximizing yield of any crop. The requirements of nine micro nutrients viz Sulphur, Calcium, Magnesium, Zinc, Copper, Iron, Manganese, Boron and Molybdenum are different for each crop. The Expert-System helps to conserve soil quality, protecting excess dose of fertilizer that results environmental protection and also economic benefit to farming community.

Vegetables are the most important factors in maintaining a healthy body. Vegetables are rich in vitamins, minerals and many other important nutrients. People who eat vegetables as part of their daily diet have a reduced risk of many chronic diseases. Various vitamins, such as C, B, E, K and A, help to keep eye, skin, teeth and gums healthy, fight infections and promote rapid wound healing, prevent damage to the body's cells, reduce the risk of uncontrolled bleeding and also help to prevent life threatening diseases like heart disease, cancer and type - II diabetes. Most importantly, vegetables are rich in a particular group of nutrients called antioxidants, which reduce free radicals from the body leading to protection from cell damage and ageing. Some vegetables have high potassium content, which is important for healthy blood pressure. Dietary fibre from vegetables helps reduce blood cholesterol levels and may lower the risk of heart disease. Folic acid helps the body to form healthy red blood cells. Women of childbearing age who may become pregnant and those in the first trimester of pregnancy need adequate folic acid to reduce the risk of neural tube defects and spina bifida during fetal development. Indian food-habit also depends largely on vegetables. Expert-System shows various raw sources of macro and micro nutrients. For any individual person calorie, macro-nutrient, vitamin and mineral requirements are different depending upon his or her body height, weight, age group, work pattern etc. Most of the books and literatures have their guidelines through static tabular form where the body weight assumed to be fixed for the particular category. This
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was the necessity to develop an Expert-System, which will dynamically calculate each
macro and micro nutrient along with calorie requirement for individual beneficiary and
also interpret their health status based on Body Mass Index (BMI) which is defined as
the body mass divided by the square of the body height and is universally expressed
in units of kg/m². It also suggests the quantity of cooked-food required, from various
Indian dishes to meet up the recommended calorie. This feature facilitates the beneficiary
to change their diet plan keeping caloric requirement constant. This tool also imparts
knowledge about the lifestyle diseases like obesity, type II diabetes, gout /uric acid etc
which is directly related to food habit. User can know about the disease, its symptoms,
factors responsible for the disease, risk factors and its prevention and control. This tool
can help individuals, extension workers and nutritionists to disseminate the research
outcome of National Institute of Nutrition effectively and easily.

1.2 Importance of Vegetable Cultivation in West Bengal in terms of State Economy

India is the second highest producer, consumer and exporter of vegetables in the
world and West Bengal holds first rank in vegetable production in India.

Table 1.1: Global Comparison in Area, Production & Productivity among leading producers

<table>
<thead>
<tr>
<th>Country</th>
<th>Area (ha)</th>
<th>Production (MT)</th>
<th>Productivity (MT/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>24560900</td>
<td>573935000</td>
<td>23.4</td>
</tr>
<tr>
<td>India</td>
<td>9396057</td>
<td>162896911</td>
<td>17.3</td>
</tr>
<tr>
<td>USA</td>
<td>1104640</td>
<td>35947720</td>
<td>32.5</td>
</tr>
<tr>
<td>Turkey</td>
<td>1111702</td>
<td>27818918</td>
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</tr>
<tr>
<td>Iran</td>
<td>876830</td>
<td>23485675</td>
<td>26.8</td>
</tr>
<tr>
<td>Egypt</td>
<td>772487</td>
<td>19825388</td>
<td>25.7</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>790500</td>
<td>16084372</td>
<td>20.3</td>
</tr>
<tr>
<td>Mexico</td>
<td>683294</td>
<td>13599497</td>
<td>19.9</td>
</tr>
<tr>
<td>Spain</td>
<td>318971</td>
<td>12531000</td>
<td>39.3</td>
</tr>
<tr>
<td>Italy</td>
<td>450186</td>
<td>12297645</td>
<td>27.3</td>
</tr>
<tr>
<td>Others</td>
<td>19096425</td>
<td>261467661</td>
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</tr>
<tr>
<td>World + (Total)</td>
<td>59161992</td>
<td>1159889787</td>
<td>19.6</td>
</tr>
</tbody>
</table>

Source: Food And Agriculture Organization of United Nations (FAO) Website February 2015
(Data for 2012,2013) & For India : Department of Agriculture Corporation and
Farmers Welfare (DAC) (Data for 2013-14).
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Major vegetables cultivated in West Bengal are Brinjal, Potato, Cabbage, Cauliflower, Chilli and Tomato. This state also exports vegetables in neighboring states like Maharashtra, Tamil Nadu etc. The demand for vegetables has risen up many overseas markets of West Asia. Though the production of vegetables in West Bengal is good, but still productivity can be increased by providing speedy, field level solution of diseases pest problem; profitability can be increased by adopting high yielding varieties, applying optimum dose of fertilizer, selecting proper sowing time for maximum market price.

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**Fig. 1 : Vegetable production in 1000 tone during 2010-11**

1st : West Bengal  
2nd : Uttar Pradesh  
3rd : Maharashtra  
Lowest : Nagaland

As per Economic times, of Times of India’s report (April 2017), West Bengal produces nearly 11 million tones potato out of which local consumption is only 5.5 million tones. Hence the state exports a huge quantity to neighboring states as well. In recent years, numbers of potato cultivators committed suicide due to loss in cultivation. One of the many reasons of this unfortunate event is high input-cost as compared to sale-price. The input cost mainly depends on seed cost and fertilizer cost. Improper seed rate, not only results high input cost, but also reduces the productivity of unit area. Application of high quantity fertilizers without having soil testing is
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another problem. These losses can be minimized by reducing input cost with proper seed rate calculation, optimum use of fertilizer and planning with price forecasting tool. A government report, the ‘NSS (National Sample Survey) Report No 558: Household Consumption of Various Goods & Services in India, 2011-12’ reveals that West Bengal has the highest consumption of potato and the rural Bengali consume average 3.794 kg potato per month.

1.3 Expert-System

An Expert-System is an interactive system where human expertise, on any subject is transformed to computerized process. It takes input from user and after processing, produces output for supporting decision making. Expert-System for Vegetables is an important component to extension workers, students and farming community for better understanding and optimization of input costs. Lack of information regarding proper variety, cultivation practice, disease-pest management, high-dose of fertilizer results in production losses and high input cost. All these results in economic losses to the farming community. ICT based Interactive Expert-System is more effective than Expert-System which are static and appeared in books and literature to impart knowledge and to automate statistical analysis like price forecasting, fertilizer dose calculation, variety selection, seed quantity requirement etc.

The main sources of getting information to the farming community are consumers, fertilizer shop, seed shop and private companies. Besides commonly all other sources mainly run on the basis of commercial motivation. Unpredictable market price also affects a lot on farming community. Perishable produce, like vegetables cannot be preserved for long time. Price prediction using statistical models can be a safeguard for farmers. The information needs of the farming community are to be realistically
understood to address the priorities of information on vegetable cultivation practices. Dissemination of knowledge through appropriate delivery mechanism plays an important role in addressing these needs. Govt. of India has adopted the mission of Digital India in 2016, where Expert-System on Agriculture is the need of the hour, to reach the farmers at their home and to teach them the scientific way of farming. The challenge is to develop the interactive information dissemination system in the interest of the rural masses involved in vegetable cultivation. Computer aided Expert-System seems to be the future mode of information dissemination. It is the most environment friendly form which can be circulated through any digital media.

1.4 Practical utility of the Expert System

The present work on the “Development of Statistical Package of Expert-Systems for Major Vegetables Grown in West Bengal” is the first of its type among vegetable farmers of West Bengal. The finding of the study will be helpful to Agriculture Extension workers, Soil Testing Laboratory Workers, Students and above all farming community. This Expert-System will help to know about the

i) Botany of vegetables.

ii) Different varieties including their productivity, cropping period and other details.

iii) Trend of price based on last 10 years wholesale market price.

iv) Scientific knowledge on Cultivation Practice.

v) Management and control of important pest and diseases.

vi) Fertilizer requirement for specific area of land.

vii) Nutritional requirement of individual beneficiary based on physical parameters.

viii) Cooking recipe of different vegetables by renowned cook of India.
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This development of Expert-System will also explore the scope of use of computer aided extension methods for information dissemination in agriculture sector. The Expert System will save effort, time and money of various segments of its users. The findings of this study may serve as a guide for further research in the field of development of Expert System.

1.5 Location of the Study

West Bengal is a state, in the eastern region of India and it is the nation's fourth-most populated state. It is also the seventh-most populous sub-national entity in the world, with over 91 million inhabitants, spread over 34,267 sq miles (88,750 km²). It is bordered by the countries of Nepal, Bhutan, and Bangladesh and the Indian states of Odisha, Jharkhand, Bihar, Sikkim, and Assam. According to the 2011 national census, West Bengal is the fourth most populous state in India with a population of 91,347,736 (7.55% of India's population). The official language is Bengali and English. Nepali is the official language in two districts; viz. Darjeeling and Kalimpong. The literacy rate is
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77.08 percent, which is higher than the national literacy rate of 74.04 percent. About 72 percent of people live in rural areas. The proportion of people living below the poverty line in 1999–2000 was 31.9 percent. Schedule caste and Schedule tribes form 28.6 percent and 5.8 percent of the population respectively in rural areas, and 19.9 percent and 1.5 percent respectively in urban areas. West Bengal supports about 7.06 percent of India's total livestock population. This state is the highest producer of vegetables in India. As per Economic times of Times of India’s report West Bengal produces nearly 11 million tones potato out of which local consumption is only 5.5 million tones. Hence the state exports a huge quantity to neighboring states. The State has two state agricultural universities and one central university which run several undergraduate and post-graduate courses in the state. Apart from that ICAR has established more than 20 Krishi Vigyan Kendras in the state to provide agriculture extension service.

West Bengal holds Rank 1, in vegetable production, in India. The major vegetables of this state are Potato, Brinjal, Tomato, Cabbage, Cauliflower and Chilli. Apart from local consumption, the excess produce of major vegetables are exported to neighboring states and countries as well. But still, there is ample scope, to increase the productivity, by using improved seed variety, managing soil fertility, timely controlling pest and diseases problem and above-all adopting scientific cultivation practices. Therefore major vegetable growing districts have been selected as location of the study.
1.6 Need of the study

Sustainable development of agriculture sector through efficient management of crop has always been a concern for the State. The studies on information need, for vegetable growers had not been conducted in a systematic way previously. Therefore, to develop a need based Expert-System, it is required to analyze the actual need of farming community and to provide relevant solution as per their requirement. Vegetable growers are in real need of information, regarding high yielding variety, off-season production for better price, scientific practice of cultivation, timely management of insect-pest and disease, proper soil health management at their doorstep. ICT is a generic term referring to technologies that are used for collecting, storing, editing and passing on (communicating) information in various forms. ICT can play a significant role in addressing the challenges and play a key role in agricultural development and growth as it can bridge the critical knowledge gap between stakeholders. ICT in agriculture is an emerging field focusing on the enhancement of agricultural and rural development in India. It involves application of innovative ways to use Information & Communication Technologies (ICT) in the rural domain. The advancements in ICT can be utilized for providing accurate, timely, relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture. In last two decades, the exchange of Research Outcome among various research institutes has become smoother through online journal, agricultural portal, e-library etc. In Barak Obama’s word, “India is fortunate to have over half of its total population of 1.2 billion under the age of 30 and this young generation is fond of electronic gadgets and use of internet. The revolutionary adoption of social media, like Facebook, WhatsApp by the young generation proves
that the application of ICT in agriculture will make it more effective for knowledge dissemination and may also make the agriculture sector lucrative to the rural youth.

In the era of Digital India, it is being said that Cyber Extension would be the major form of technology dissemination in near future. However, it is observed that the rural populations still have difficulty in accessing information in order to take timely proper decision. It is known to us that information availability is mostly demand driven rather than supply driven. The challenge is not only to improve the accessibility of computer to the rural population but also to improve its relevance in local level. The conventional way of information dissemination through leaflet, pamphlet, newspapers, magazines etc. are not meeting the expectation of the farmers for several reasons. The drawbacks of the traditional approach are as follows (Sharma et al., 2002): i) irrelevance of the delivered information; ii) inability of the system to cover all the farmers; iii) the lack of avenues to improve the performance; iv) unaccountability for the advice given by the system. Therefore, this initiative of introducing ICT based Expert-System can reduce the gap of information and can timely disseminate proper and adequate information.

1.7 Objective of the Thesis Work done

i) To analyze the actual information-need of any vegetable growers and to develop an expert system according to their need.

ii) To forecast price of particular vegetable based on last 10 years monthly price data using Triple exponential smoothing (Holt-Winters method).

iii) To develop interactive system that will calculate and suggest fertilizer requirement for specific area of land based on input parameters set by any user.
iv) To impart scientific knowledge about variety, season, cultivation practice and important diseases and pest management.

1.8 Limitation of the Expert-System

The system has been developed in Windows based platform. If similar system is developed in Android platform, more number of beneficiaries can use the system. The system based on the data obtained from various farmers purposively selected from different blocks of various districts of West Bengal. Therefore, the results may directly be applicable to that particular area, although its result may have relevant application to other areas having similar environmental and economic background. During data collection, a great care has been taken to minimize the biasness of response from the selected sample units (farmers) population but still prejudice and biasness in their responses cannot be overruled.