Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 678-684

Brajendra
Principal Scientist, Soil Science, ICAR-IIRR, Rajendranagar, Hyderabad, Telangana, India

AK Vishwakarma
Princiapl Scientist, Agronomy, ICAR-IISS, Bhopal, Madhya Pradesh, India

KM Bujarbaruah
VC, AAU, Jorhat, Assam, India

KA Pathak
Retd. Joint Director, ICAR Research Complex for NEH Region, Mizoram Centre, Kolasib, Mizoram, India

Correspondence
Brajendra
Principal Scientist, Soil Science, ICAR-IIRR, Rajendranagar, Hyderabad, Telangana, India

A web based decision support system on fertility management of soils of Mizoram

Brajendra, AK Vishwakarma, KM Bujarbaruah and KA Pathak

Abstract
'Being connected' has been central to the hierarchy of needs as perceived by the human beings since times immemorial. Even during the ancient time period the people used to be on move, in the quest of knowledge and information and their main means of getting connected with the intended target group used to be contacts and their visits. It is not surprising to find out that Information & Communication Technologies (ICT) of late has come to the rescue of all kinds of information seekers.Computer technology is playing a major role in agrotechnology transfer and land evaluation. The role of computer technology in database management, simulation, geographic information systems and decision systems has gained wide acceptance during the last decade (Jones *et al*. 1986). The rapid development of Information Technology (IT) has spread its network in all aspects of agriculture. In Soil Science integration of this technology has lead to a development of entirely new discipline called Soil Informatics- a fusion of soil science with that of computing.

Keywords: Decision Support System, Fertility Management, Soils of Mizoram

Introduction
The information generated for any scientific research has to reach farmers so that they could extract maximum advantage out of it. It is information which is taking us ahead not technology alone. Information technology which is one of the most promising technologies of the present era, can be utilized for this very purpose using various powerful tools such as "Information support systems", "Decision support systems"or "Expert support systems". Expert systems are computer application programs that take the knowledge of one or more human experts in a specific filed and computerize it so that it is readily available for use. In agriculture expert systems can be used for extending the research to farmers and it can work as problem solving tool for them. A decision support system is a computing system which uses organized knowledge about a specific field to display and interact with the facts and figures and solves a problem. The most innovative part of decision support systems is the ease with which a wide range of information can be presented and used in making decisions. This information ranges from quantitative information, including statistical relationships such as regression equations and physical and chemical laws, to less precise concepts and ideas that have been gained by experience in the field. Decision support systems can be connected to external databases. By having access to a database, the decision support system can infer site conditions from available data by considering, for example, the geographic location of the site.

Why a web based decision support systems for Mizoram
Mizoram literally meaning, "Land of the highlanders" lies at an altitude varying from 30 m msl to more than 1300 m msl, with steep hill slopes. It is abundant with green thick forest, rich in wide range of flora and fauna. The vegetation of Mizoram can be broadly classified as tree forests, bamboo forests and abandoned jhums with shrubs. The total geographical area of the state is about 21,081 sq.km, out of which more than 90 per cent area comes under hills and remaining 10 percent comes under valley lands. The state is mostly inhabited by Mizo tribes and the farmers practice *Jhum* cultivation in hill slopes and wet land rice cultivation in valley areas. The Mizoram hills lying between 22 to 24 degree 15 N latitude and 92 degree 35 to 93 degree 25 E longitudes exhibit a climosequence ranging between per humid tropic humid cool temperate and exhibit different ecosystem at altitude ranging from 50 to 1700 msl. Mizoram is one of the eight states of the north eastern hill region and consists of eight districts. The state has a total geographical area of 21081 sq. km. (NEC, 2002) and is comprised of a total of 824 villages (L.C, 2002). With a total population of 8.91 lakh (LC, 2001) there is near uniformity across the larger tribal communities in Mizoram, (Singh1996). Diversity in the land use system is quite common. The elevation of the state varies from 32m to 950m from msl. The temperature during summer ranges from 18 to 29 ^{o}C. While in winters it is 11 to 24 ^{o}C.

The vegetation is tropical moist deciduous forest and bamboo forest. Compared to the other hill states in the North Eastern States of India, the slope of the hill sides in Mizoram is much steeper. Small farmers with scarce capital resources populate the upland environments, which are usually marginal for farming. In the hill farming there are no clear-cut boundaries. Individual fields/plots can scarcely be vegetated, while some patches are definitely under crops and others are under thick forest. Some patches of *Jhum* can carry only one kind of crop yet others carry mixtures of up to dozen kinds of crops. But, often a pattern emerges from all these and there are enough treasures of wisdom associated with such kind of indigenous farming practices. In the absence of any thing of importance for the land of the highlander, soil is the only natural resource of importance a Mizo farmer has. Sustaining agriculture means sustaining soil fertility. No information as such existed in Mizoram regarding fertility status of all the districts/blocks and all the major events of soils. A Mizo farmer is largely unaware of what is there in store for him below the ground. It is said that as human societies become increasingly urbanized, fewer people have intimate contact with the soil, and individuals tend to lose sight of the many ways in which worlds ecosystems are impacted in far reaching ways by processes carried out in the soil. A web based system for fertility management of soils of Mizoram just aims bringing out in wide open the treasures/gems a Mizo farmer is having below the ground. Computers can be effectively used for rapid communication of soil and plant test report alongwith suitable recommendation on fertilizer and amendments to the users. It is possible with the use of modems, e-mail and internet or through the direct computer networking among soil testing laboratories and state/ block/ village level agricultural extension agencies. At present, this seems to be unrealistic in Indian conditions but in near future due to rapid computerization and commercialization of agriculture this may soon be a reality. Electronic device like computer which are fast, accurate, versatile ans diligent and which convert raw data in to meaningful information can be used for interpretation for soil and water test results and also for providing the necessary recommendations with the help of suitable software.

Objectives of the programme

1. To develop soil, rainfall, crop databases that will enable multiple users such as farmers, researchers, planners and policy makers.
2. To provide knowledge based interactive system for assistance in decision making regarding soil fertility and crop productivity.
3. To develop decision aid and management strategies to assist farmers to deal with soil fertility problems.
4. To develop decision support system that enables a farmer to know the current status of soil fertility, potentialities and problems if any. As soil fertility status of the place is known, to present before the users its interpretation and likely solutions.

Why web based programming

Web pages are the files that travel through internet and carries information from a server to a client that requested them. These files are created using special software programs or programming environments. A web site must be intelligent enough to accept users input and dynamically structure web page content, tailor made, to a user's requirement. For this creation of interactive web pages is required. Interactive web pages accept input from users and based on the input received furnish customized web pages, both in content and presentation, to the user.

Architecture of the programme

The overall computerized system is user friendly and interactive and has been designed in such a manner that even a person with limited computer skills can handle it easily. The total software size is however in several MBS but can easily be started in a PC. The main user interface is provided in the form of popup Menu-Bar with Menu options viz. Mizoram at a glance, Crop cafeteria of Mizoram, Jhums of Mizoram, Soils and land uses, Soil survey and sampling, Soil fertility management etc as shown in Fig. Each of these menu options has a few Sub-menu options which when clicked will open a certain form to perform certain task. The variety list for a particular main menu is entered through sub menu options that is available to the user by clicking. The programme has been fully developed using web technologies viz. Hypertext Markup Language (HTML) and ASP (Active Server Pages) to facilitate on user with little computer awareness. The data base at back end is designed using Excel spread sheets and reports are generated as web pages. The system is described and the extent to which it has met its objectives is discussed in length with emphasis on the requirements of the end user. This can be useful for primary stakeholders, researchers, planners and others as it will give desired informations at one platform regarding various aspects of farming in Mizoram. Some of the web pages like lime recommendation has the potential to be made online and this can be very first of its kind effort in India. A computer programme written in HTML loads which aids –

a. Maintaining database of soil, water and plant test results.
b. Interpretation of soil, water test results and
c. Providing the recommendations based on results.

Various sub-menu in the programme enables the users select the appropriate options for the recommendations they are interested in. The output of the results can be seen either on the monitor or can be taken as a hard copy. The programme is also designed to provide the output in text format so that user can make use of the data in any of the work processor. The guidelines followed in majority of the soil testing laboratories in India for interpreting pH, OC, avail. NPK and micronutrients have been used. This programme will help the user in

a. maintaining the data base of the results of numerous soil and water samples.
b. obtain quick and accurate interpretation of soil and water test results
c. necessary nutrients recommendations
d. using the database so maintained for developing soil test summaries for a particular nutrients and for a particular village or district and also for monitoring fertility status over a period. Some of the main menu and its submenus are described as below:

Following viewpoints were taken into consideration while developing the database:

1. Database requirements specified
2. Knowledge based requirements specified
3. Database system implemented.
4. Knowledge based system implementation both in electronic and paper based forms.

A number of resources have been developed for supporting the needs of the users of agricultural production systems.

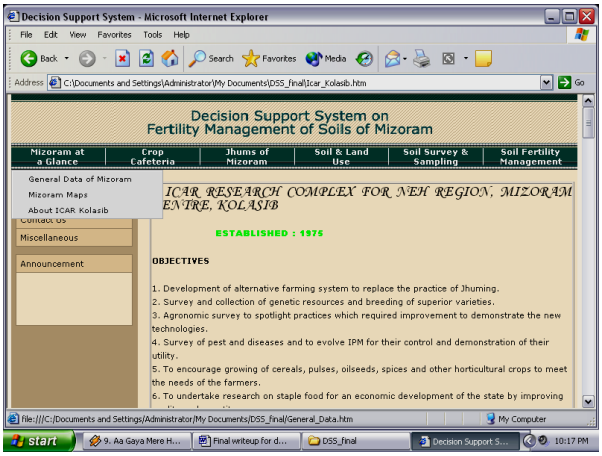
1. Soil and weather database located on the web page.
2. A lime cultivation software for calculating lime doses
3. Software support for crop rotation and their management
4. Output templates—excel templates for presenting out puts of specifying simulations.
5. DSSFMSM were also used to crop yield estimates for local users to develop local crop production databases. These database can be started, hosted and accused on PC's to address regional crop management issues such as planting time, soil moisture requirements, crop choice. Rules of thumb were also derived from these databases.

About the programme menus and submenus

Mizoram at a glance

This is the first main menu/screen of the program, which allows users directly access to different sections of the program by clicking the buttons on the left. It has main menu along with submenu having following links

1.Introduction
2.Genera data of Mizoram
3.Mizorammaps
4. About ICAR Research Complex for NEH Region Regional centre, Kolasib



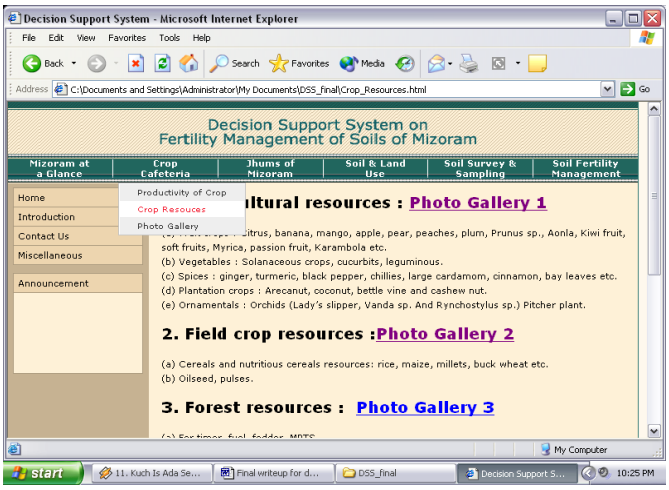
Crop cafeteria of Mizoram

This is the second main menu/ screen of the program. It has main menu along with submenu having following links

1. Crop Resources of Mizoram-
2. Production and productivity of crops

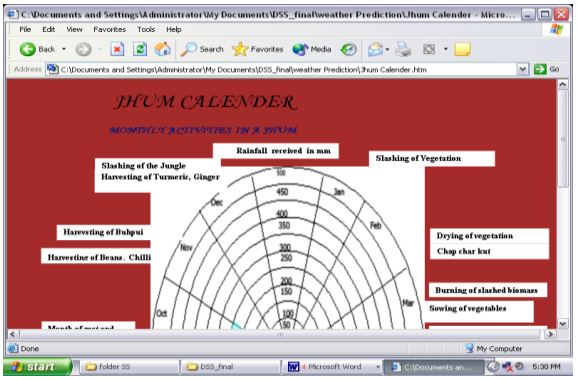
Crop resources of Mizoram

The state of Mizoram, by and large, is characterized by fragility, marginality, inaccessibility, cultural heterogeneity, and ethnicity. However, the land of the highlander is blessed with rich biodiversity and region has several firsts in India. The screen shots will give a good glimpse of what are its agricultural resources



Jhum calender

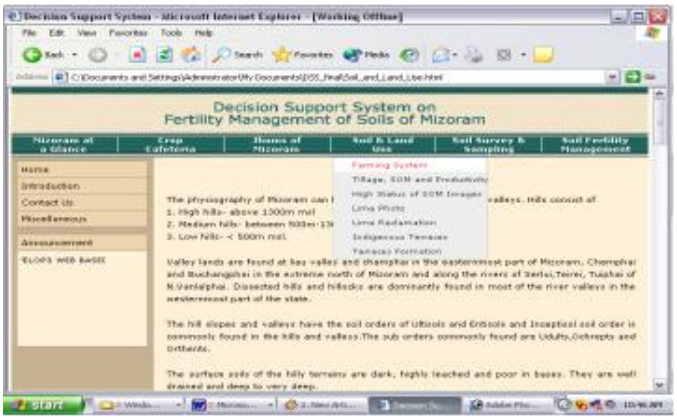
Jhuming, locally called as *Tlangram* in Mizoram, is an age old farming system and still continues. Farmers gradually accumulated local ecological knowledge and experiences through decades of trial-and-error experimentation in and with the natural environment. Slash-and-burn techniques are an integral part of these rotational farming systems, which has short cropping period followed by long fallow period to restore soil fertility. *Jhuming* is often associated with economic security to the farmers and there are deep rooted cultural importance accorded to *Jhuming* by the aboriginal tribes of Mizoram.



The farming operations are so much a part of social, economic and religious lives of so many tribes of the region that offers an intricate relationship between the ways of the farming and their practices on the farm. **Jhum calender** traces month wise farming operations prevalent in Jhums for which tribals often carve mountains to grow their foods.

Soils and land uses

Mizoram is a hilly undulating terrain and is susceptible to large scale soil erosion.



Farmers are aware that top soil is their supporting layer and it is upon the productiveness of this layer that their survival and prosperity depends. The traditional wisdom of various soil conservation measures like bunds made of stones or boulder or earthen dams are mostly local soil and water conservation practices and are location specific and accordingly vary in purpose. They conserve soil in situ by constructing stone and earthen bunds. Mostly, they utilize their own knowledge as a starting point and are compatible with local approaches to land use. Maintenance has not presented serious problems for the people. These measures can be visualized in various photo galleries.

Soil survey and sampling

This is the fifth screen of the program. It has main menu along with submenu having following links

1. Introduction

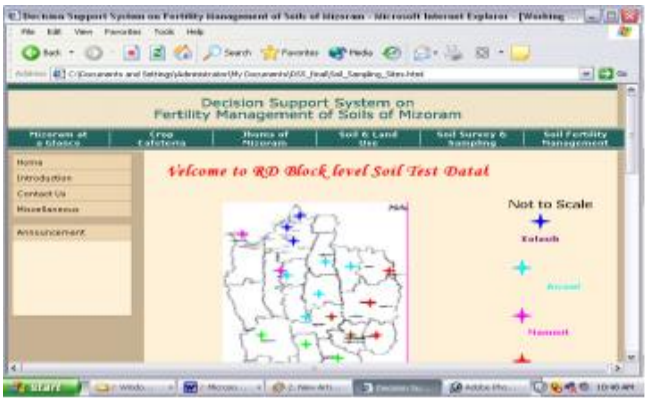
It is a fact that soil test will be no good than the soil sample taken. Most of the soil test reports fail in practice due to error in soil sampling techniques. Various screens in the section will put enough information about how to sample, when to sample and how much to sample. The drudgery involved in manual compilation of the soil test data has its own limitations and analysis report generation, communication to its beneficiary is time consuming. A soil test based data accessing system is very much required. At the same time considering the fact that a large number of users are not technically sound in computer awareness so shifting to web based technologies are far more easier than complicated programming languages like visual basic, foxpro etc. The present system is rapid, fast and reduces delays in data inputs and provides the users with a simple, easy to handle, user friendly method to retrieve accurate and efficient soil test data retrieval.

2. Soil Testing: The soil test data management system developed provide routine processing of data and production of summary routine processing of data and production of summary tables reports in easy, efficient and web friendly manner. It is a web based system and has a special feature of on line data entry allowing where the flexibility to re-enter / edit/ add the data entry from any place provided they have internet connectivity.

3. Soil Sampling: The drudgery involved in manual compilation of the data has its own limitations and report generation, communication to its beneficiary was time consuming. A report system of data results delivery system is very much required. At the same time considering the fact that a large number of users are not technically sound in computer awareness so shifting to web based technologies are far more easier than complicated programming languages like visual basic, foxpro etc. The present system is rapid, fast and reduces delays in data inputs and provides the users with a simple, easy to handle, user friendly method to retrieve accurate and efficient data production.

4. List of soil sampling sites: This is one of the most important screen of the whole programme. A browser can access block level detailed soil test database of Mizoram just by clicking any star. In the left side, if a browser wishes detailed district wise soil test database can be accessed.

Furthermore for the convenience of browser another map below this screen will provide block level crop nutrient requirement for more than twenty crops/cropping systems of Mizoram.



5. Soil site suitability studies: Higher production and productivity of crops can be ensured if soil site suitability studies are done and cultivation of crops are ensured by adequate site specific studies (Sehgal,1991). The soil site suitability could be assessed with proper land evaluation methodology. This can be assessed either by qualitative or quantitative methods. In general wide variation in crop yield is observed when the crops are grown irrespective of their altitudinal variations. The reasons for yield variations are assigned to the variation in landforms (Hill soils being acidic are differentially suitable for plant growth). the aim of this menu is to provide evaluation criteria for the soil suitability of a hillock by matching soil properties with that of the constraints and their rating parameters.

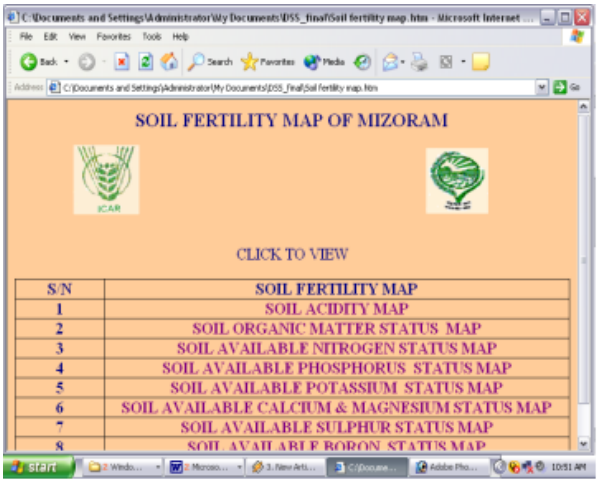
Setting limiting values for land-use requirements

Limiting values are the values of a land quality or land characteristic that determine the class limits of land suitability for a certain use. The standard FAO land suitability classification is followed.FAO has laid criteria to assess The land suitability for supporting the land use on a sustained basis. This means that the use must not progressively degrade the land. Many changes of land use cause an initial loss of land resources: for example, when forest is cleared for tea plantations or for arable farming, there is always a loss of forest habitat and wildlife as well as of soil and accumulated plant nutrients. The module describes methodology and examples of finding soil site suitability on hillforms of Mizoram. if soil erosion is not controlled, the new land-use type cannot be sustained. According to the land-use type, the upper limit of the land quality "erosion hazard" might be set in terms of slope, which is as follows:

- plantation tea, high level of management: 20
- smallholder tea, average level of management: 15
- rain-fed arable crops with simple soil conservation practices: 8

It is then possible to distinguish up to three classes of suitability, although this is not always necessary. Land classed as highly suitable is the best land for the specified use; moderately suitable land is clearly fit for the use but has limitations; while marginally suitable land falls near to (but above) the limit for suitability. Land that is not suitable may be subdivided into permanently not suitable, where there are limitations to sustained use that are clearly impractical to overcome; and currently not suitable, where such limitations could be overcome but not at a currently acceptable cost.

5. **Nutrient availability indices**



Soil fertility management

This is the last but most important screen of the program, which allows users directly access to different sections of the program by clicking the buttons on the left. This part of the program allows users to enter soil test results and then it generates lime, macronutrient recommendations for any of the major crops grown in Mizoram at the yield goal of users choice. This is first of its kind effort in India in its own way. Lime recommendation system can generate lime requirement for any acidic soil across the globe. It has following links

1. Introduction about soil test and nutrient recommendation
2. Lime recommendation
3. Soil quality
4. Soil nutrient role
5. Nutrient recommendation
6. Soil fertility problems- Soil Fertility Problems in Agriculture

Cultivated highly-weathered soils commonly suffer from multiple nutrient deficiencies, and nutrient balances are generally negative (Tandon 1993, Mokwunye *et al*. 1996). Major arable soils are often poorly suited to high-input agriculture. Agricultural development efforts, therefore, must be directed towards the improvement of productivity and sustainability of smallholder production systems.

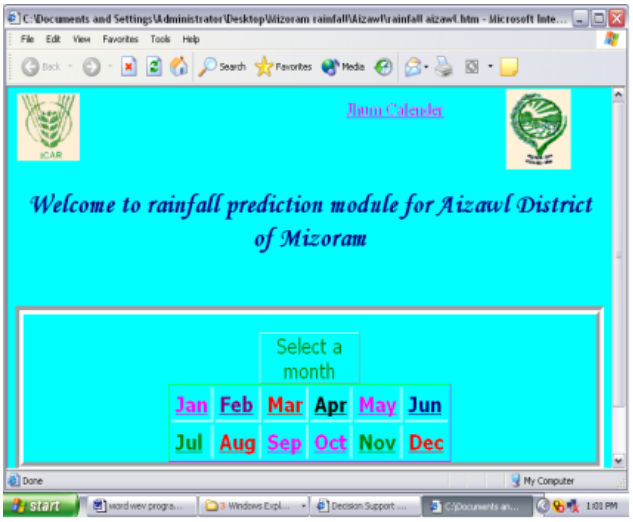
External nutrient inputs are essential to improve and sustain crop production on these soils. The decline of crop yields under continuous cultivation has been attributed to factors such as acidification, soil compaction and loss of soil organic matter (Juo *et al*. 1995). Thus, application of organic materials is needed, not only to replenish soil nutrients but also to manage the agro ecosystem in such a way that nutrient sources are generated, recycled and maintained.

Maintaining Soil Fertility

Maintaining soil fertility is an important step in sustainable agriculture. Before stating how soil fertility is maintained, the causes of soil fertility decline must be stated. Plants uptake minerals pass the minerals to the leaves, and the leaves fall back to the earth where the process starts all over again. Farmers remove the crops before the minerals can be replaced in the soil. There are ways to lesson the mineral loss, but there is no way to stop it from happening completely. Minerals must be replaced from the outside. To replenish minerals the application of fertilizers is recommended.

7. Soil fertility maps

Some other important links



District wise Rainfall prediction model for Mizoram

Rainfall influences many farming operations such as the preparation of land, sowing, harvesting and threshing. Several weather components affect the crop growth hence crop weather relationships are of immense practical value. Selection of crops and cropping patterns are based on the water availability, and on the number of wet months i.e., those in which rainfall exceeds evapotranspiration etc. In a state like Mizoram management of available water is of paramount importance. The state is mostly dependent on rain water resources for its agricultural operations. It is very pertinent for a farmer to know how much rainfall can be expected at least in a time interval. Twenty five years (1980- 2004) monthly rainfall data collected at the centre were used to determine the probabilistic distribution of rainfall. The data were arranged in descending magnitude and each record was assigned a number called Rank Number (m). Ranking order method of Doorenboss and Pruit (1975) was then used to make rain plotting position. For highest value of rainfall data it was given Rank Number 1 and the last Rank number for the lowest rainfall data. Probability numbers F a (m) in per cent was calculated for these rank numbers by Doorenboss and Pruitt (1975) formula :

$$F\,a\,(m) = 100\,m / n+1$$

Where n = number of records (in present case 25)
m= rank number

Minimum assured rainfall predicted at 25, 50, 75 &96 % of probability level

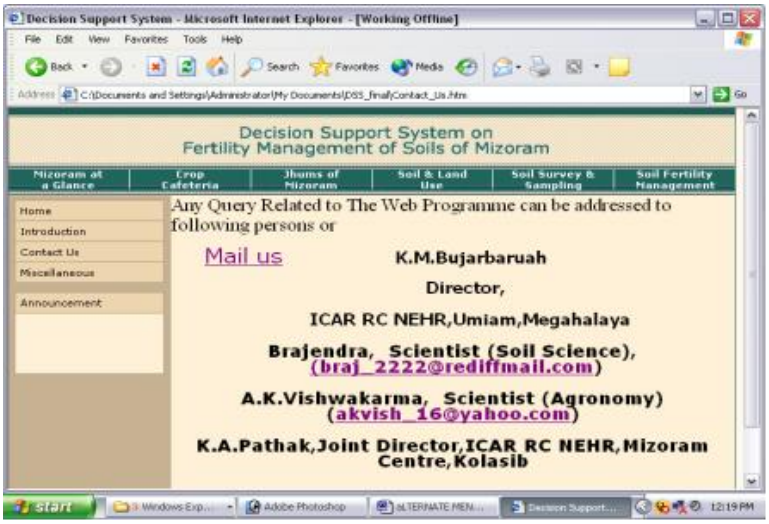
S/N	Minimum assured rainfall at Probability level(mm) for Kolasib district				
	Months	**25 (%)**	**50(%)**	**75(%)**	**96(%)**
1	January	7.5	4	0	0
2	February	40.12	25.5	15	0
3	March	156.5	114	58.42	0
4	April	338	163.2	106.5	23.6
5	May	434.5	358.8	204.6	88.3
6	June	464	347.3	251.1	151.8
7	July	522.5	424.17	306.8	138.45
8	August	524.85	453.49	334	161.5
9	September	386.74	328.25	224	102.3
10	October	218.4	177.91	88	51.25
11	November	59.1	11.18	0.05	0
12	December	19.9	1.5	0	

Rainfall prediction module- determines amount of rainfall which can be predicted at any level of probability for all the districts of Mizoram. It is essential for a state like Mizoram to know the minimum assured rainfall for atleast weekly as several crops are grown in areas without consideration of the climate. Much of production potential of the vast resources can be utilized by knowing the weather parameters. One very important environmental risk in a state like Mizoram which is having tropical to subtropical to sub humid climate was of rainfall. The state is completely dependent on rain water resources received. And for management of the already depleted perched water resources for crop production is a big challenge for one and all.

Alternate Screens

These screens accompanies in all the screens and it has following sub links

1. **Home** : Hosts the programme
2. **Introduction**: Tells about the programme
3. **Contact us**: Any query can be addressed to the authors
4. **Miscellaneous**: Related links on Vermicomposting, Crop residues, Crop livestock integration
5. **Announcement**s: Any fresh development will be notified in the box.



Conclusion

Information and Communication Technology intervention in soil test based database accessing system will provide a significant advantage in societal transformation, economic development as well as strengthening of knowledge base through reaching the vast unreached masses scattered through

the perennial dense forest, vast deserts and great mountains in the north eastern hill region of India. This ICT revolution has changed the world scenario with a very fast rate of growth. ICT intervention in a remote and isolated place like Mizoram will help to improve communication, increase participation, disseminate information, share knowledge and skills among the farmers to meet the location specific information needs and enabling farmers accessing information rapidly and remotely. This can prove to be powerful empowering tools to the poor masses of the final frontier of Indian peninsula ie Mizoram. Generations of isolation in this tiny state of India is now having an opportunity to effectively integrate with the outside world with the powerful tools of information technology. When the rules of the farming have changed and more and more innovations led farming are fastly changing the scenario at farm levels in India and abroad, it is here that a lesson or two learning will lead to uprising among the farmers. Mizoram and Northeast as a whole can be the torch bearers in this field of agriculture.

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