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Alternative Cropping Possibilities for Rainfed Crop Based on Length of Growing Period Driven by Web User Interface

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Abstract-- The crop growth and yield of rainfed crop is dependent on rainfall amount and soil moisture status in the root zone. The water balance climatology of any rainfall region helps in selecting crops and cultivars for better net return. Inadequate information on this aspect sometimes fails to rationalize the natural resources. Water-balance models have been used to examine the various components of the hydrologic cycle (for example, precipitation, evapotranspiration, irrigation demand, soil-moisture storage and runoff). A water-balance model driven by a Web User Interface (WUI), referred to as the Thornthwaite water-balance model developed and it permits the user to easily estimates of water-balance components, Moisture Availability Index, Length of Growing Period for rainfed crops, suggests the alternative crops possibilities and draws the graphical sketch of Soil moisture index for a specified location and can be used as a research tool for precise natural resource management.

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I. Introduction

The rainfed crop growth is directly related to the rainfall amount and soil moisture status in the root zone. Rainfall is the main contributing factor for growth and yield of rainfed crops. Water balance models are aimed at computing the soil moisture index from the available weather records. Thornthwaite Water-balance models have been used as a means to examine the various components of the hydrologic cycle (for example, precipitation, evapotranspiration and runoff). Such models have been used to estimate the global water balance (Legates and Mather, 1992; Legates and McCabe, 2005); to develop climate classifications (Thornthwaite, 1948); to estimate soil-moisture storage (Alley, 1984;), runoff (Alley, 1984, 1985; Yates, 1996; Wolock and McCabe, 1999), and irrigation demand (McCabe and Wolock, 1992); and to evaluate the hydrologic effects of climate change (McCabe and Ayers, 1989; Yates, 1996; Strzepek and Yates, 1997; Wolock and McCabe, 1999). Paper provides description of thornthwaite water-balance model that is driven by Web User Interface (WUI) developed by the College of Agriculture Information Technology, Anand Agricultural University, Anand, Gujarat, India. The WUI permits the user to easily estimate Moisture Availability Index, Length of Growing Period for rainfed crop and suggests the selection of alternative crops and draws the graphical sketch of Soil moisture index for a specified location and can be used as a research tool for precise natural resource management. The program can run on any computer platform.

II. Materials and Methods

Web based Thornthwaite water-balance mode1 has been implemented as a layered structure having three layers viz., User Interface layer (UIL), Application layer (APL) and Database layer (DBL). Each layer having its own specific functions. The User interface layer is implemented using combination of HTML, JavaScript and CSS. Application layer is implemented using PHP (http://php.net). It is an open source general-purpose server-side scripting language originally designed for Web development to produce dynamic Web pages. Database layer is implemented using MySQL (http://www.mysql.com) database for storing user data. It is the world's most used open source relational database management system (RDBMS) as a server providing multi-user access to a number of databases. Thornthwaite water-balance mode1 can be accessed using the browser of the user's system. The WUI is completely menu driven and offers user-friendly screens organized to simplify and reduce effort to understand.

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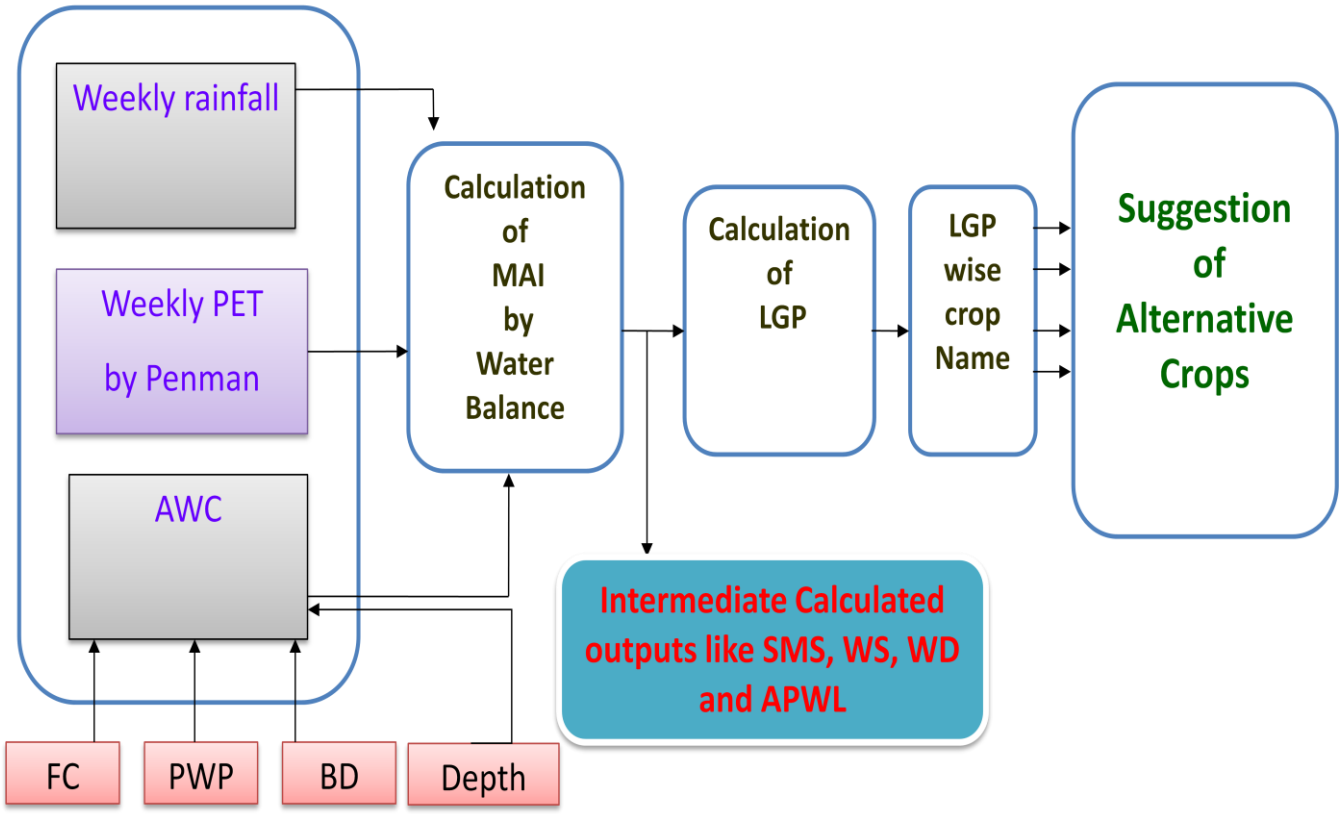

Fig.1 Process flow diagram of possible alternative crops

Where PET= Potential Evapotranspiration, AWC = Available Water Capacity, MAI = Moisture Availability Index, LGP = Length of Growing Period, FC= Field Capacity , PWP=Permanent Wilting Point, BD= Bulk Density, SMS=Soil Moisture Storage, WS= Water Surplus, WD=Water Deficit, APWL=Accumulated Potential water loss

Based on weekly total rainfall and other required data, MAI is calculated by water balance method for every week, then the continuous period (in days) having MAI > 0.5 was taken as the Crop Growing Period (CGP) or Length of Growing Period (LGP). Based on the LGP, possible alternative cropping systems have been suggested along with their LGP. The process flow diagram of rainfed crops is presented in Fig.1.

III. RESULTS AND DISCUSSION

The main objective of this paper was to estimate moisture availability index (MAI), length of growing period (LGP) and suggest alternate cropping possibilities on the basis of well established scientific approach. By pooling the location specific innovative ideas on new crops from scientists and extension workers, and superimposing this information on the soil moisture index based crop growing period, the suggestions on possible alternative crops / cropping system were arrived. The Home page (Fig.2) of the software presents the user a brief introduction, objectives and process model on the software. The WUI has menu items like “Home”, “Entry” and “Search”.

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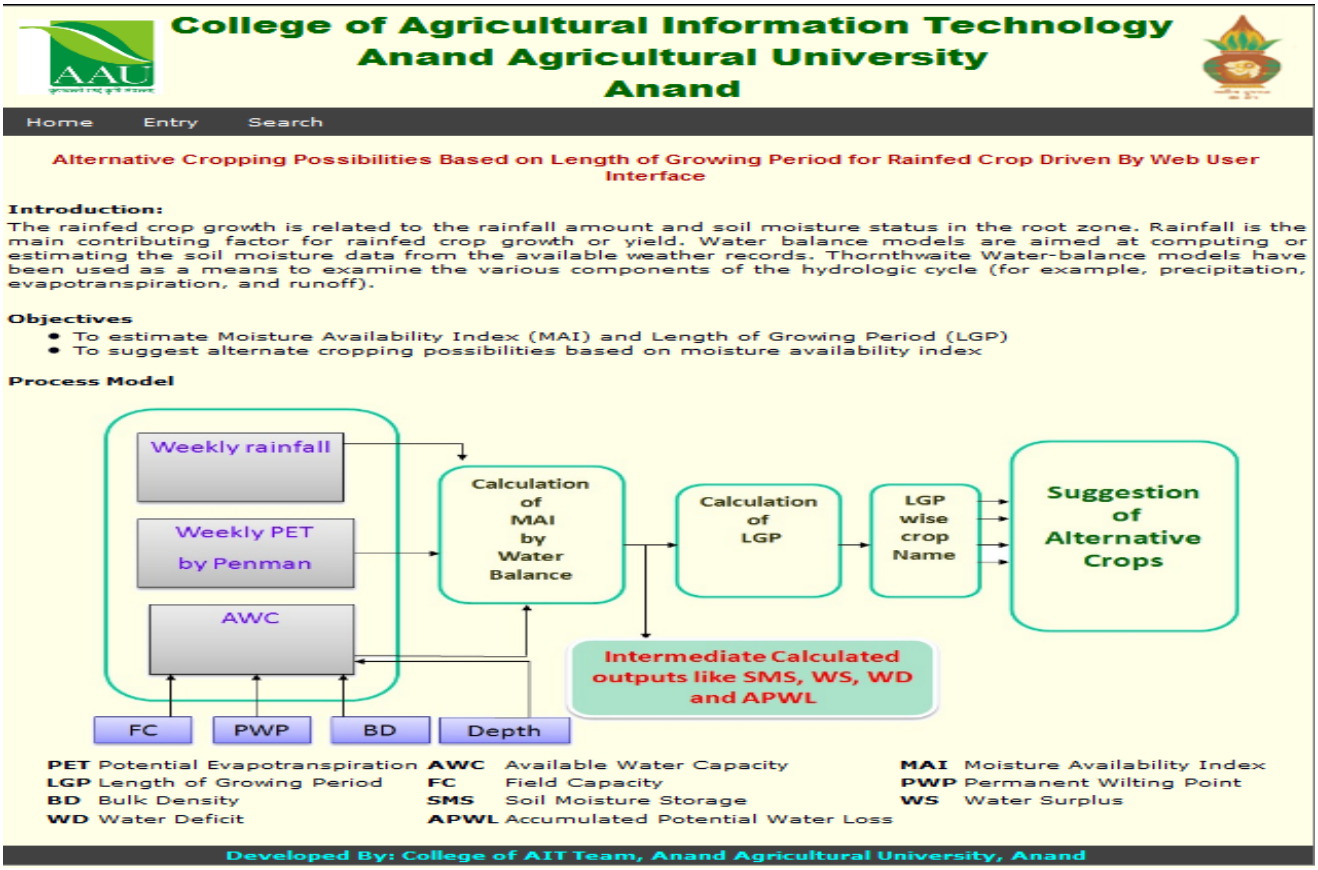

Fig.2 Home Page

In Fig.3, the user has to select the appropriate options and enter the values for the respective parameters. The data entry form for rainfall and PET is shown in Fig.4.

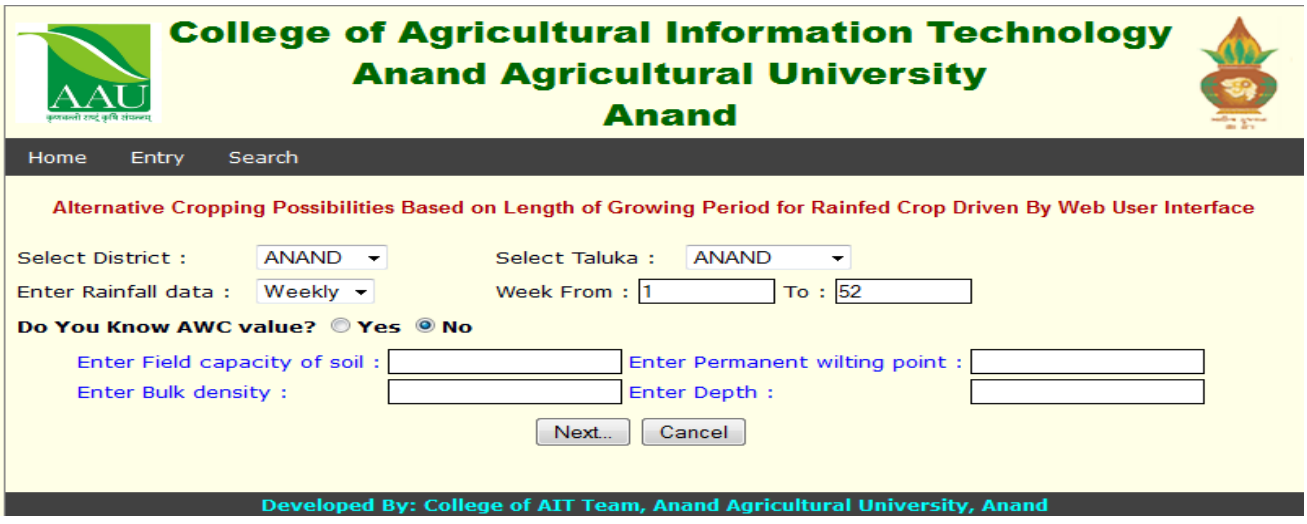

Fig.3 Input Parameters

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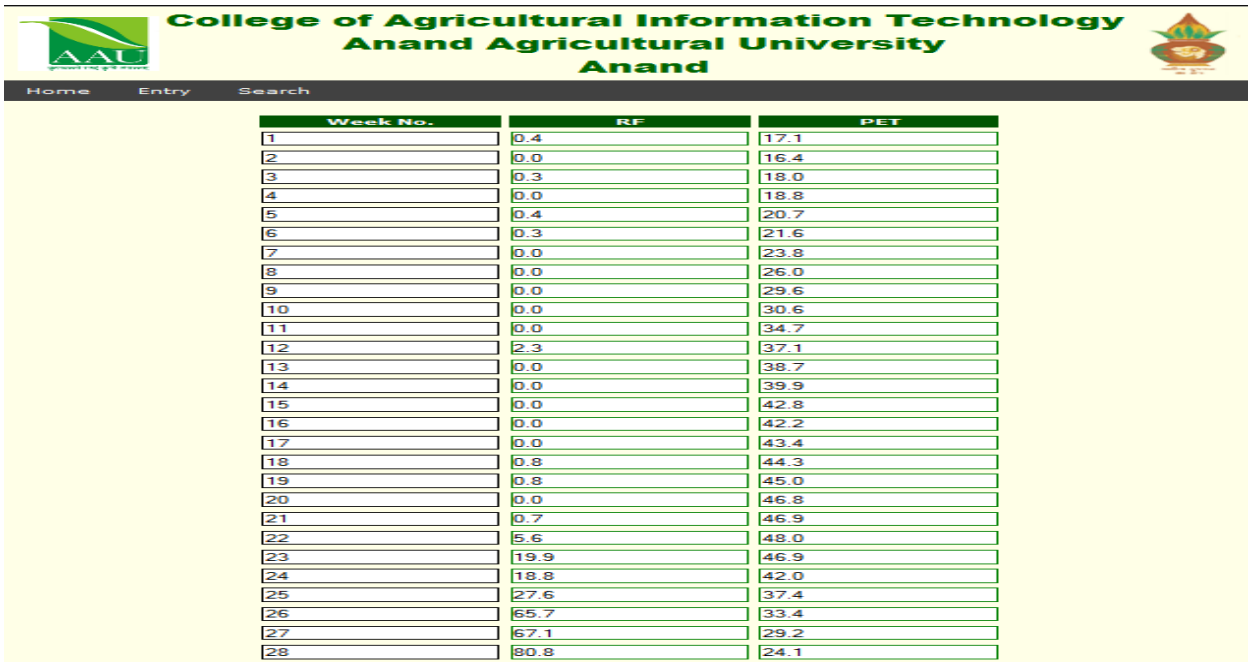

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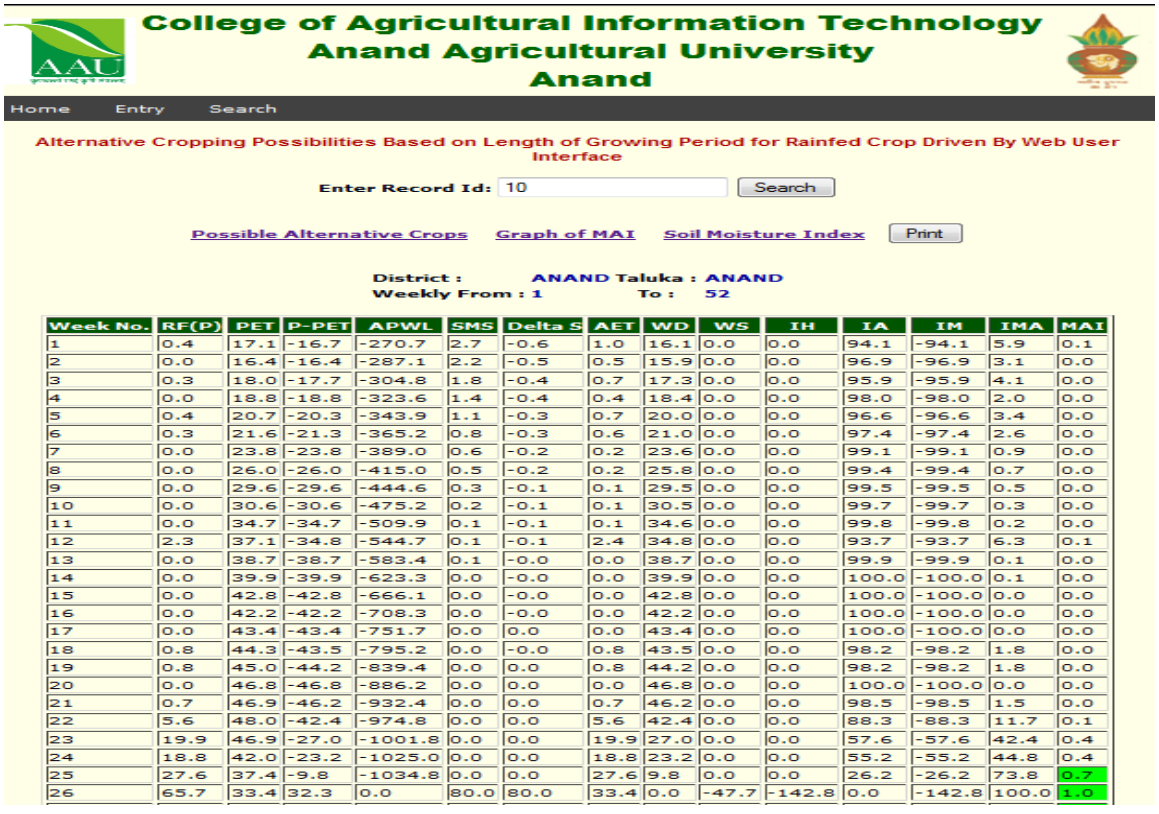
Home Entry Search

Week No.	RF	PET
1	0.4	17.1
2	0.0	16.4
3	0.3	18.0
4	0.0	18.8
5	0.4	20.7
6	0.3	21.6
7	0.0	23.8
8	0.0	26.0
9	0.0	29.6
10	0.0	30.6
11	0.0	34.7
12	2.3	37.1
13	0.0	38.7
14	0.0	39.9
15	0.0	42.8
16	0.0	42.2
17	0.0	43.4
18	0.8	44.3
19	0.8	45.0
20	0.0	46.8
21	0.7	46.9
22	5.6	48.0
23	19.9	46.9
24	18.8	42.0
25	27.6	37.4
26	65.7	33.4
27	67.1	29.2
28	80.8	24.1

Fig.4 Data Entry Form for Rainfall and PET

Fig.5 depicts the way soil moisture index was arrived at for location. The soil moisture index for different weeks is shown through graph. MAI ≥ 0.5 was considered as a suitable for successful rainfed crop growing. Graphical sketch of soil moisture index given in Fig. 6 shows that moisture availability during 25 to 41 meteorological standard weeks is adequate for crop growth. This period is considered as the crop growing period.



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Home Entry Search

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Enter Record Id: 10 Search

Possible Alternative Crops Graph of MAI Soil Moisture Index Print

District : ANAND Taluka : ANAND
Weekly From : 1 To : 52

Week No.	RF(P)	PET	P-PET	APWL	SMS	Delta S	AET	WD	WS	IH	IA	IM	IMA	MAI
1	0.4	17.1	-16.7	-270.7	2.7	-0.6	1.0	16.1	0.0	0.0	94.1	-94.1	5.9	0.1
2	0.0	16.4	-16.4	-287.1	2.2	-0.5	0.5	15.9	0.0	0.0	96.9	-96.9	3.1	0.0
3	0.3	18.0	-17.7	-304.8	1.8	-0.4	0.7	17.3	0.0	0.0	95.9	-95.9	4.1	0.0
4	0.0	18.8	-18.8	-323.6	1.4	-0.4	0.4	18.4	0.0	0.0	98.0	-98.0	2.0	0.0
5	0.4	20.7	-20.3	-343.9	1.1	-0.3	0.7	20.0	0.0	0.0	96.6	-96.6	3.4	0.0
6	0.3	21.6	-21.3	-365.2	0.8	-0.3	0.6	21.0	0.0	0.0	97.4	-97.4	2.6	0.0
7	0.0	23.8	-23.8	-389.0	0.6	-0.2	0.2	23.6	0.0	0.0	99.1	-99.1	0.9	0.0
8	0.0	26.0	-26.0	-415.0	0.5	-0.2	0.2	25.8	0.0	0.0	99.4	-99.4	0.7	0.0
9	0.0	29.6	-29.6	-444.6	0.3	-0.1	0.1	29.5	0.0	0.0	99.5	-99.5	0.5	0.0
10	0.0	30.6	-30.6	-475.2	0.2	-0.1	0.1	30.5	0.0	0.0	99.7	-99.7	0.3	0.0
11	0.0	34.7	-34.7	-509.9	0.1	-0.1	0.1	34.6	0.0	0.0	99.8	-99.8	0.2	0.0
12	2.3	37.1	-34.8	-544.7	0.1	-0.1	2.4	34.8	0.0	0.0	93.7	-93.7	6.3	0.1
13	0.0	38.7	-38.7	-583.4	0.1	-0.0	0.0	38.7	0.0	0.0	99.9	-99.9	0.1	0.0
14	0.0	39.9	-39.9	-623.3	0.0	-0.0	0.0	39.9	0.0	0.0	100.0	-100.0	0.1	0.0
15	0.0	42.8	-42.8	-666.1	0.0	-0.0	0.0	42.8	0.0	0.0	100.0	-100.0	0.0	0.0
16	0.0	42.2	-42.2	-708.3	0.0	-0.0	0.0	42.2	0.0	0.0	100.0	-100.0	0.0	0.0
17	0.0	43.4	-43.4	-751.7	0.0	0.0	0.0	43.4	0.0	0.0	100.0	-100.0	0.0	0.0
18	0.8	44.3	-43.5	-795.2	0.0	-0.0	0.8	43.5	0.0	0.0	98.2	-98.2	1.8	0.0
19	0.8	45.0	-44.2	-839.4	0.0	0.0	0.8	44.2	0.0	0.0	98.2	-98.2	1.8	0.0
20	0.0	46.8	-46.8	-886.2	0.0	0.0	0.0	46.8	0.0	0.0	100.0	-100.0	0.0	0.0
21	0.7	46.9	-46.2	-932.4	0.0	0.0	0.7	46.2	0.0	0.0	98.5	-98.5	1.5	0.0
22	5.6	48.0	-42.4	-974.8	0.0	0.0	5.6	42.4	0.0	0.0	88.3	-88.3	11.7	0.1
23	19.9	46.9	-27.0	-1001.8	0.0	0.0	19.9	27.0	0.0	0.0	57.6	-57.6	42.4	0.4
24	18.8	42.0	-23.2	-1025.0	0.0	0.0	18.8	23.2	0.0	0.0	55.2	-55.2	44.8	0.4
25	27.6	37.4	-9.8	-1034.8	0.0	0.0	27.6	9.8	0.0	0.0	26.2	-26.2	73.8	0.7
26	65.7	33.4	32.3	0.0	80.0	80.0	33.4	0.0	-47.7	-142.8	0.0	-142.8	100.0	1.0

Fig.5 Soil Moisture Index calculation

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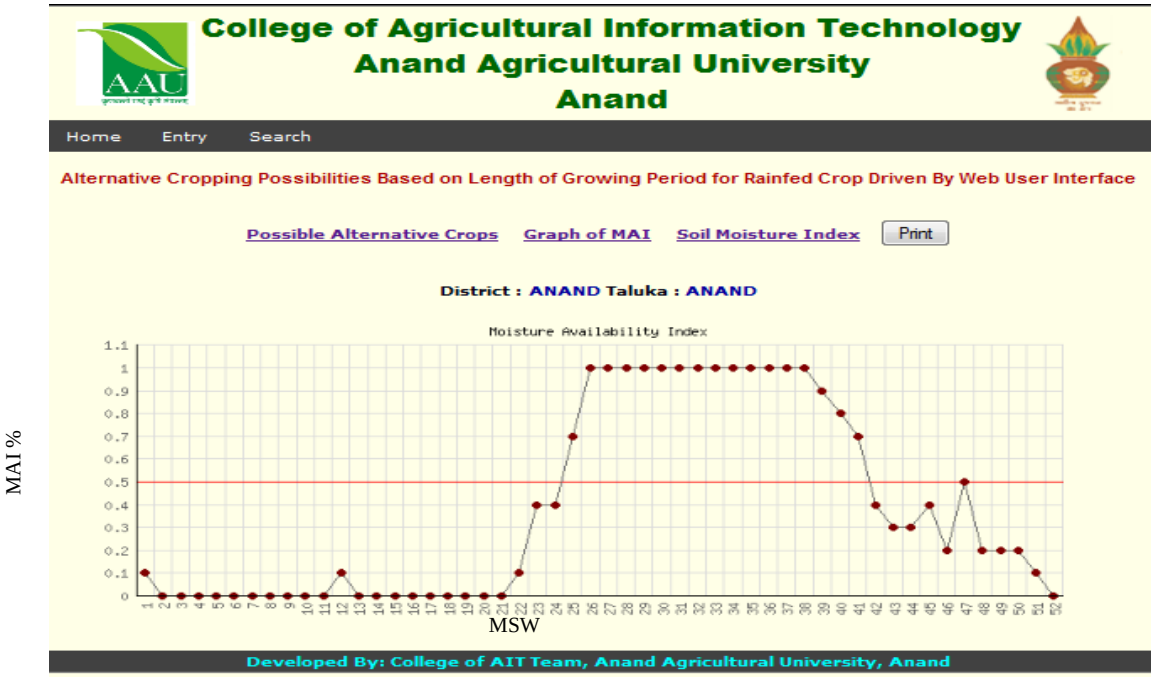
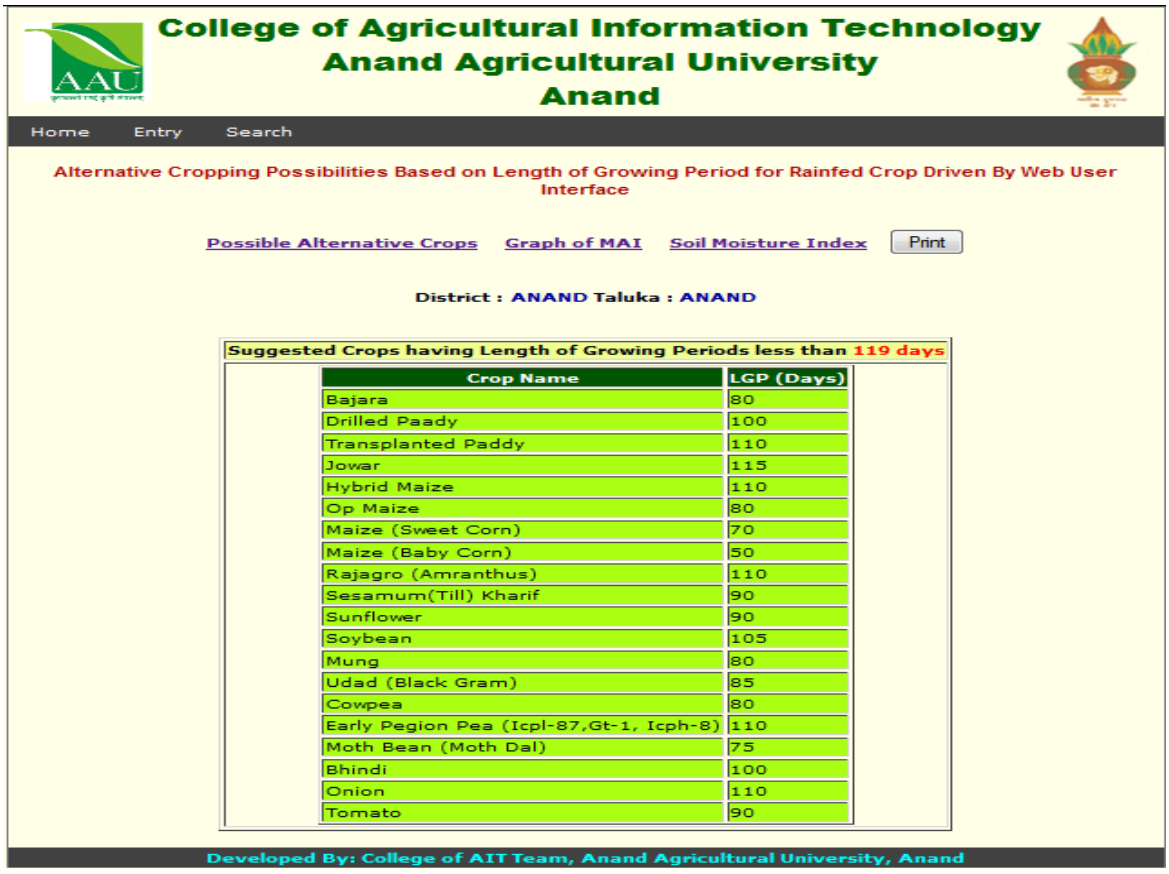


Fig.6 Graphical sketch of Weekly Soil Moisture Index

Taking into consideration crop growing period and run off harvest and its utilization, possible alternative crops/cropping systems were suggested for rainfed areas. The information regarding possible alternative cropping systems is presented in Fig.7. This can motivate the framers to try alternative crops and cropping system.



Crop Name	LGP (Days)
Bajara	80
Drilled Paady	100
Transplanted Paddy	110
Jowar	115
Hybrid Maize	110
Op Maize	80
Maize (Sweet Corn)	70
Maize (Baby Corn)	50
Rajagro (Amranthus)	110
Sesamum(Till) Kharif	90
Sunflower	90
Soybean	105
Mung	80
Udad (Black Gram)	85
Cowpea	80
Early Pegion Pea (Icpl-87,Gt-1, Icph-8)	110
Moth Bean (Moth Dal)	75
Bhindi	100
Onion	110
Tomato	90

Fig.7 Possible alternative cropping systems

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