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Site suitability for turmeric production in India —A GIS interpretation

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Abstract

India has 1,49,410 hectares area under turmeric cultivation with a total annual production of 527,960 tonnes. The compound growth rate of turmeric area is 6.30 and production is 3.37 when comparing 2000 levels over those of 1970. It shows that the increase in area is not having significant effect over the production rate. In the present paper the suitability maps and area productivity graphs are given to show the position of turmeric in the important turmeric growing states. It was found that site suitability is an important factor to determine the productivity of the crop. A highly suitable location may not result in larger yields than suitable or marginally suitable areas. Suitability maps are useful to determine areas which will have the greatest success for growing a particular crop in a region.

Keywords: Spice, Turmeric, Site suitability, DIVA-GIS, Compound growth rate.

IPC code; Int. cl.[8] — A01G 1/00, A23L 1/22

Introduction

Turmeric, ***Curcuma longa* Linn.** (*Haldi*) of family Zingiberaceae is native to India and Southeast Asia. India is the largest producer, consumer and exporter of turmeric; Indian turmeric has been known to the world since ancient times. Turmeric, derived from rhizome contains brilliant yellow orange colour. It has been used as a dye, medicine and flavouring since 600 BC. Turmeric is closely related to ginger. With its rich curcumin content, which imparts the distinctive yellow colour, warm and mellow flavour and other inherent qualities, Indian turmeric is considered the best in the world. India exports turmeric to discerning countries like Japan, Sri Lanka, Iran, North African countries, US and UK. In India over 149,410 hectares are under turmeric cultivation with a total production of 527,960 tonnes. The state of Andhra Pradesh topped India both in cultivated area and production, with 56,820 hectares and 283,540 tonnes, respectively. Tamil Nadu follows with 17,000 hectares area and 64,540 tonnes production. Among the traditional turmeric growing states productivity is highest in Andhra Pradesh and Karnataka at around 4,900 kg/ha.

The compound growth rate of turmeric area is 6.30 and production is 3.37 when comparing 2000 levels over those of 1970 (Ref. 1). It shows that the increase in area is not having a significant

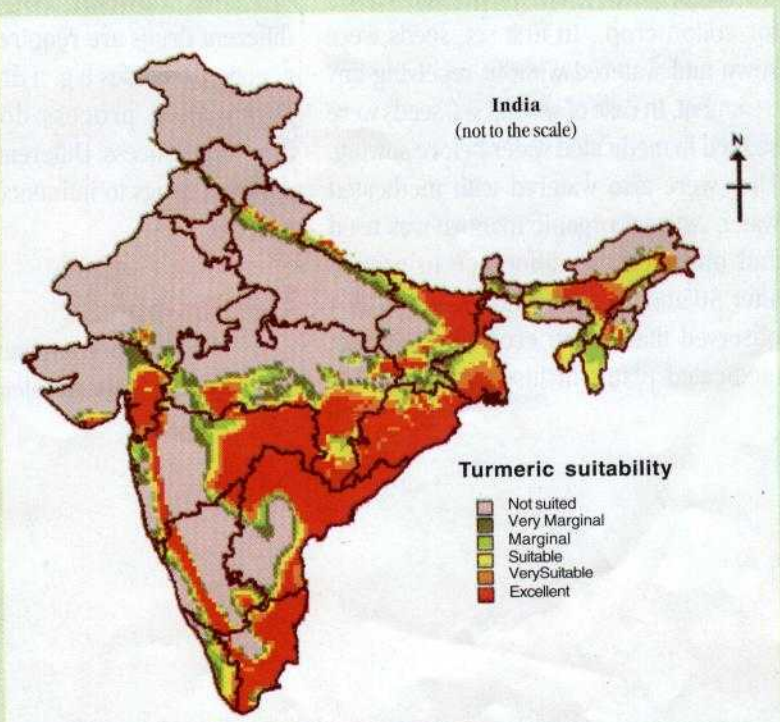

Fig. 1 : Site suitability map of turmeric drawn with the help of Eco-crop model DIVA-GIS

effect on the production rate. As turmeric is an important crop of India, it is essential to study the distribution of the crop in the states and to find out the areas of suitability for turmeric cultivation. Environmental suitability is an important aspect which has a direct impact on the productivity of the crop. Climatic variables are the principle drivers of geographic distribution[2, 3].

Agricultural crop distribution is rarely limited to a crop's native range. Increased crop range is largely the result of the introduction of crops into new areas which may not provide optimum growing conditions. Land suitability analysis is a prerequisite for sustainable agricultural production.

The process of decision making involves a number of criteria involving the range of factors that influence crop production. Many factors, such as soil fertility and *p*H, vary continuously with space and time, and it is not possible to incorporate them into a large scale suitability model.

The process of land suitability classification is the evaluation and grouping of specific areas of land in terms of its suitability for a defined use. The main objective of the land evaluation is the prediction of the inherent capacity of a land unit to support a specific land use for a long period of time without deterioration, in order to minimize the socio-economic and environmental costs[4]. Land suitability analysis is an interdisciplinary approach by including the information from different domains, such as soil science, crop science, meteorology, social science, economics and management. Being interdisciplinary, land suitability analysis deals with information, which is measured in different scales including ordinal, nominal and ratio scales.

In this study, 30 years of productivity data across a number of states in India were used to study the trend of productivity over the environmentally suitable regions of India and to assess the impact of climatic suitability on production. Similar models have been used extensively to evaluate the potential impact of climate change on shifts in the production and growing regions of various crops[5-8].

Turmeric can be grown in diverse tropical conditions from sea level to 1500 m elevation, at a temperature range of 20-30°C with an annual rainfall of 1500 mm or more, under natural rainfall or irrigated conditions. Though it can be grown on different types of soils, it thrives best in well-drained sandy or clay loam soils.

Materials and Methods

Data on area and production of different turmeric growing states of India for 30 years were collected from the Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi (2004). The states which are cultivating turmeric as an important crop are included in this study. Area and production curves for all these states were prepared using 30 years of data to understand the dissimilarity of compound growth rate of area and production. Optimum climatic conditions for turmeric cultivation were determined from a literature search. The growing season length is defined as the number of growing days available for the crop and varies from 210 to 270 days. Turmeric cultivation is classified as short duration (210 days) and medium or long duration type (240-270 days)[9]. Site suitability maps were prepared using Eco-crop predictions of DIVA-GIS putting the optimum temperature, rainfall and growing season of Indian turmeric (Fig. 1). This model predicts the adaptation of a particular crop over geographic areas[10]. In this model the growing period is defined in days between Gmin and Gmix (start of growth and end of the growth, respectively). The suitable temperature and rainfall parameters used in this model are:

KTMP-Absolute temperature that kills the plant

TMIN-Minimum average temperature at which the plant will grow

TOPMIN-Minimum average temperature at which the plant grow optimally

TOPMAX-Maximum average temperature at which the plant will grow optimally, and

TMAX-Maximum average temperature at which the plant cease to grow.

In the same way for rainfall it has used RMIN and RMAX-Minimum and Maximum rainfall during growing period and ROPMIN and ROPMAX-Optimum Minimum and Maximum rainfall of growing season.

The suitability map is prepared on a 10-minute grid and includes: the maximum diversity of the climatic factors such as temperature and rainfall. The map of India highlights the major regions for turmeric site suitability.

Results and Discussion

The concept of sustainable agriculture or farming (SA/SF) involves producing quality products in an environmentally benign, socially acceptable and economically efficient way[11], i.e. optimum utilization of the available natural resource for efficient agricultural production. In order to comply with these principles of SA one has to grow the crops where they suit best, which requires a thorough land suitability analysis[12]. Land suitability analysis must be carried out in such a way that local needs and conditions are reflected in the final decisions.

Andhra Pradesh has about 57,000 ha under turmeric cultivation and during the year 2003 production of 284,000 tonnes giving a productivity of 4,990 kg/ha was reported. When the last 25 years data were analysed (Fig. 2) it was found that during 1970-1985 the productivity was almost steady averaging 2000-3000kg/ha. But during 1985-1990, production was less though the area had increased. It is interesting to note that during 1995-2000 the area has gone very high but production level is almost same 4000-5000 kg/ha. The actual reason for this may be due to the farmer's ignorance about the suitability of the land. The suitability map indicates that in Andhra Pradesh the land is very suitable for turmeric cultivation leaving a small patch in the central and western part, which is not suitable for turmeric. When analysed at district level it was found that the districts like Nizamuddin Guntur, Nellor, Vishakapattanam and Medak, have considerable area under turmeric cultivation and the site suitability is also very high. Again, districts like Kurnool, Mehaboobnagar and Anantapur are also having excellent areas under turmeric cultivation, but these districts have less suitable growing conditions. The total cultivation of these districts is low hence, pulling down the total productivity of the state.

On the other hand it is interesting to note that in Assam the area increased markedly from 4,000ha in 1970 to 12,000ha in 2000, but the productivity remained constant between 1979 to 1990. During 1990-1995 both area and productivity decreased. Between the years 1995-2000 the area increased but the productivity increased only marginally from 600-700kg/ha (Fig. 3). Productivity, however, remains high due to the environmental suitability which is very suitable for turmeric cultivation. Karbianglong, Kamrup, Nowgong and Sanitpur are very suitable for turmeric cultivation. Brahmaputra valley is highly flood prone and is an important factor influencing the seasonal agriculture. Farmers of Assam grow very good varieties like 'Nowgam' (20% dry recovery), 'Hajo' (21% dry recovery) and 'Barhola Jorhat', (25% dry recovery). 'Dadra Gauhati' (23.2% dry recovery) and 'Maran' (26% dry recovery) are local varieties[13]. Availability of many good quality local varieties indicates the suitability of the crop in Assam. The process of decision making involves a range of criteria and large amounts of expert knowledge and judgements[4]. At present, the productivity of turmeric in Assam is only 700 kg/ha, but with improved infrastructure like good marketing and storing facility, irrigation, etc. and awareness about the suitability of the crop, this may increase the position of turmeric in the state.

In the case of Bihar, another very suitable area for turmeric cultivation, analysis shows that when the area was very high in 1970 around 9000 ha the productivity was low but gradually productivity increased to a considerable level. The cultivated area has fallen and has come down to 2,000 ha in 2000 (Fig. 4). In 1970 the productivity was only 500 kg/ha, in 1975 it rose to 2500 kg/ha and gradually became steady around 1500-1000 kg/ha. The varieties used here are all local varieties. Lack of market demand, export and post harvest facilities effect the production. People produce for their own consumption, with no intensive farming. Knowledge of environmental suitability may help the farmers to boost the interest in turmeric cultivation in the state.

In Kerala turmeric is cultivated in almost all the districts. However, the land is only marginally suitable for turmeric cultivation, hence productivity of turmeric is low in spite of improved varieties and technologies. Kerala is the land of Ayurveda and turmeric with high medicinal properties is in good demand. During the early 1970's the area under turmeric was high (4,500 ha) which decreased drastically to 2,500 ha in

1975-76 (Fig. 5). Productivity, however remained same (1,500-2,000 kg/ha) in spite of the decrease in area under turmeric. Contrarily, in the early 80's an increase in the area was observed (3,500-4,000 ha) followed by a simultaneous increase in productivity (3,000 kg/ha). This is possibly due to intense competition, good market demand and adaptation of HYV (High yielding variety) and improved technology. It is interesting to note that the area is fluctuating but productivity is constant (the ratio of area / production is constant). The reason can be explained as the Kerala farmers are always flexible in their crops, but are aware of modern technology. The knowledge of suitability may help to concentrate the cultivation in the suitable districts to meet the high demand for the crop.

In the case of Karnataka, a small patch from North to South is highly suitable (Fig. 6) which includes the districts like Shimoga, Chamarajnagar, Uttara Kannada, Belgaum, Hassan, Mandya, Mysore, Kodagu and Dharwar. When the area under turmeric cultivation is analysed it was found the higher productivity area comes from the above districts only (Fig. 6). During 1985-1995 the productivity is very high though the area under cultivation has also marginally increased. Interestingly it shows the production started declining from 1995 to 2000 though the area is increasing and it shows the inclusion of some districts like Richur, Dakshin Kannada and Bijapur which fall within unsuitable areas and so the productivity is 4,900kg/ha while during 1985-1995 the productivity range was 14,000-16,000 kg/ha. This huge gap can only be explained as the area increases, the production/area ratio falls. Farmers should give importance to the environmental suitability to get the optimum return of their labour.

Tamil Nadu is very suitable to excellent and farmers follow advanced cultivation methods, with the good demand in the market. The rise and fall of the area under cultivation is having a proportional trend with productivity and may be the only state which is showing a very good correlation in the curve (Fig. 7) so the suitability with the good technology shows a definite impact on the productivity. The state is having a current production area of 17,000 ha and productivity of 4,500 kg/ha.

Orissa is another traditional state which is third in the productivity level having 2,400 kg/ha. It is also a state of high suitability for the crop. Though infrastructure is poor (irrigation, transport, marketing), the area has risen from 10,000 ha to 25,000 ha over the past 30 years (Fig. 8). Production also shows a rising trend leaving a few years. These gaps can be due to draught or flood as the state is very prone to such natural calamity. If proper importance is given to turmeric cultivation to this highly suitable area a high quantity of production is possible.

In Maharashtra area under cultivation is about 6600 ha. Suitability is high except some central part, which consist the districts like Ahmednagar, Aurangabad, Solapur and others. The productivity of the state is around 1, 238 kg/ha which is poor and may be due to the more interest to other spice crops like chilly. The curve shows a proportional trend (Fig. 9). The knowledge of suitability may improve the interest of the farmers about the crop turmeric.

Conclusion

Climate and soil requirements that are available for crops are generally not adequate to understand the crop yield. It is just an indication of the suitability of a location for specific crops. The result should not be construed to indicate definitively that a certain crop will not grow in a particular area. It is not that a highly suitable location will result in larger yield than suitable or marginally suitable areas. This model can only indicate the area that will have the greatest likelihood of success of growing a particular crop in a region. Final identification requires an in depth study of other environmental factors and infrastructure like irrigation, modern technology, marketing and storage facility that may limit crop growth and production. A personal small scale or single state survey may provide much more information. Precision farming involves the use of most advanced technologies like GPS, GIS, Remote Sensing and VRT (Variable Rate Technologies). Such systems are designed to monitor, analyse and control plant production parameters with the aim to optimize expense and ecological effects and to increase the income. To fulfil such contrasting aims the first prerequisite is to select the best suitable crop for the area. The land suitability analysis will best suffice such a basic need.

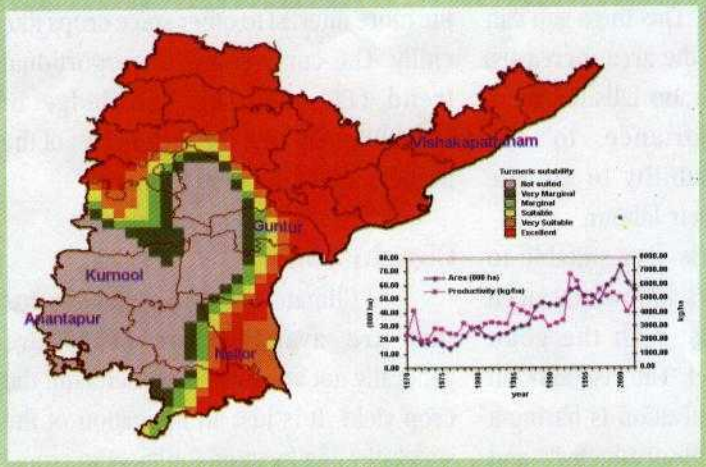

Fig. 2 : Suitability map of turmeric and area and productivity graph of Andhra Pradesh

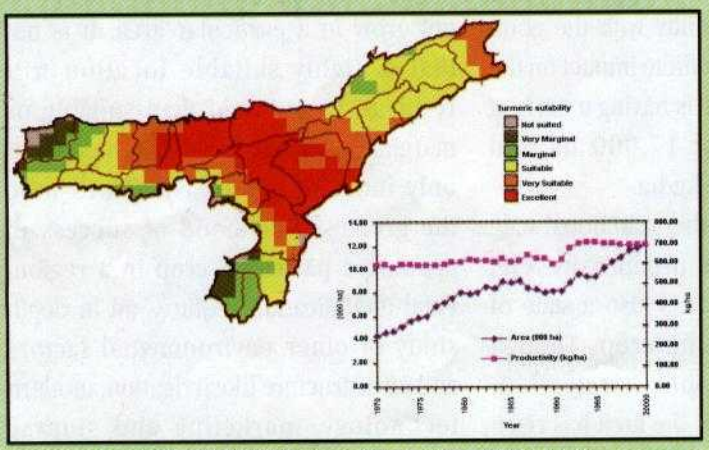

Fig. 3 : Suitability map of turmeric and area and productivity graph of Assam

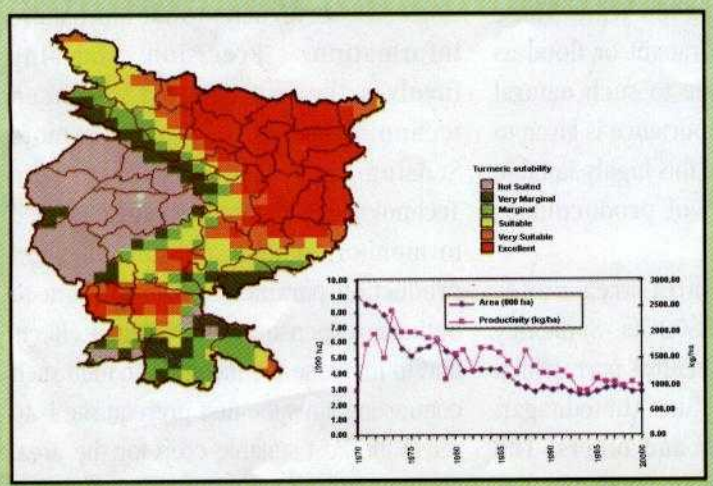

Fig. 4 : Suitability map of turmeric and area and productivity graph of Bihar

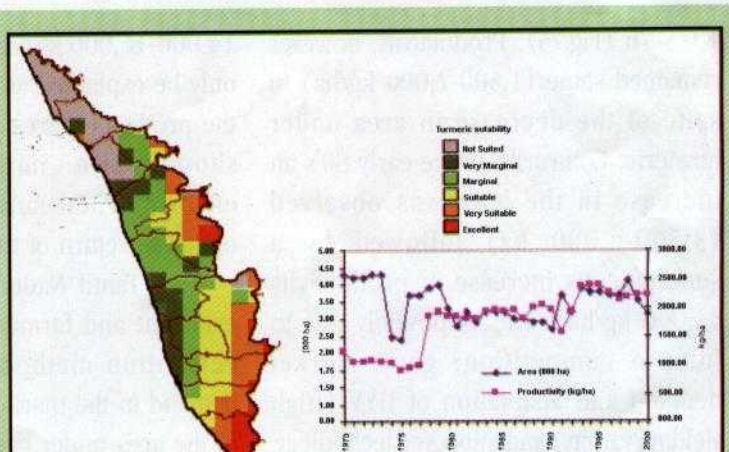

Fig. 5 : Suitability map of turmeric and area and productivity graph of Kerala

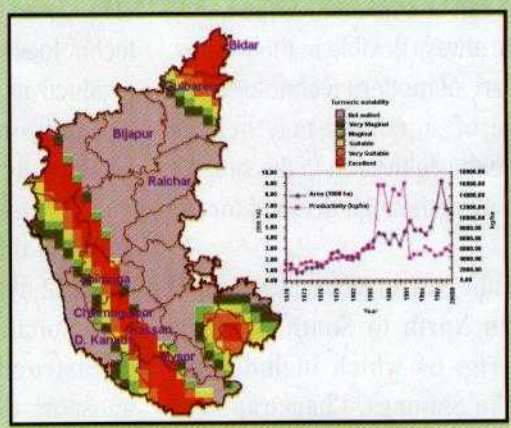

Fig. 6 : Suitability map of turmeric and area and productivity graph of Karnataka

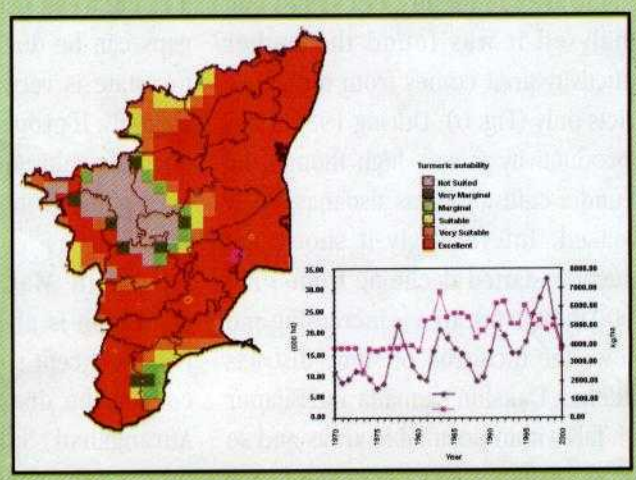

Fig. 7 : Suitability map of turmeric and area and productivity graph of Tamil Nadu

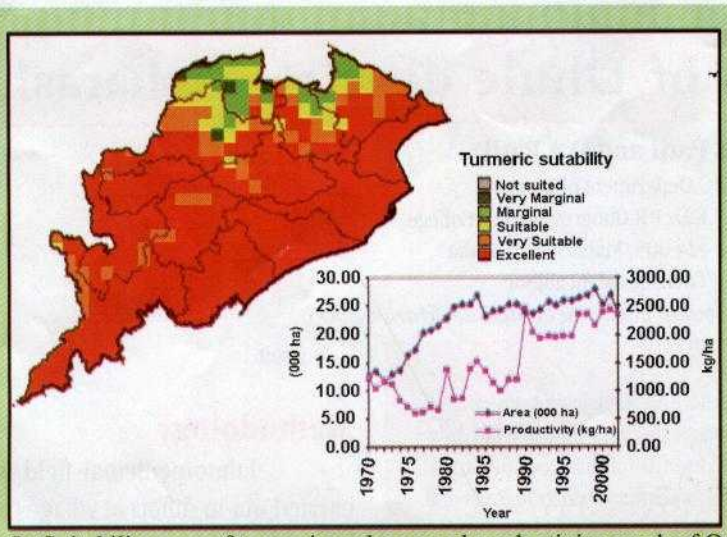

Fig. 8 : Suitability map of turmeric and area and productivity graph of Orissa

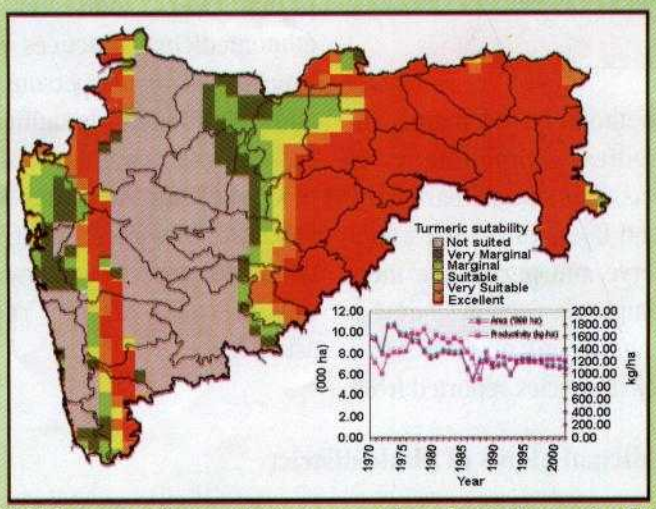

Fig. 9 : Suitability map of turmeric and area and productivity graph of Maharashtra

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