Sustainable Horticultural Crop Production in India

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India

Introduction

India is a huge country located on the southern part of the continent Asia. I've briefly studied India through numerous geography classes. Even with the brief overviews on India, I still don't know a whole lot about the country besides the population, religion, and types of food consumed. Since I don't have a lot of previous knowledge of India, this project will be a great opportunity to expand my knowledge and facts about India.

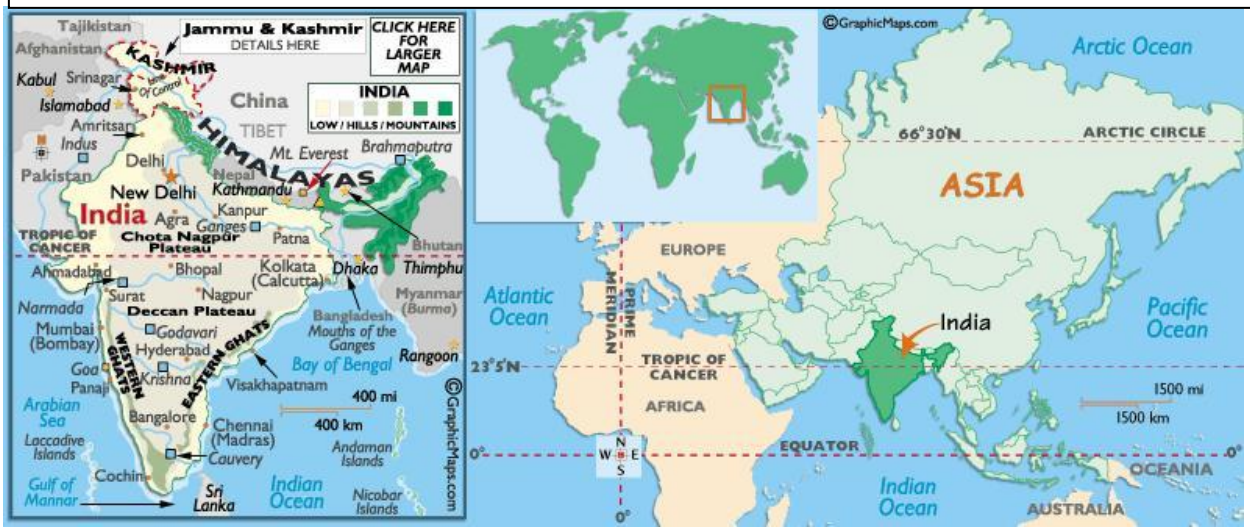
Geography

India has 7 different geographic divisions: The northern mountains, fertile plains of the Ganga, Coastal plains, Eastern and the Western Ghats, The plateaus, and the Islands. The diverse land forms of India span from "snow clad high mountain ranges of the Himalaya to sea coasts of sandy, muddy, rocky, shingle and coralline nature through forests, grasslands, deserts, wetlands, mangroves and coral reefs." (Ecosystem of India)

As the seventh largest country in the world, India has an area stretching more than 3, 287, 263 square km and is within the range of $8^{o}4'$ to $37^{o}6$ north latitudes and from $68^{o}7$ to $97^{o}25$ degrees east longitude. The southern part of India protrudes into the Arabian Sea and the Bay of Bengal. India also has rainforests and numerous long rivers. India has a few large island

groupings called Andaman, Nicobar and Lakshadweep. The Andaman and Nicobar Island region consist of 572 small islands located to the east of India's mainland. The Lakshadweep islands are west of the mainland peninsula in the Arabian Sea consisting of about 27 islands. The coastline of India stretches out about 7000 km. The climate varies from tropical monsoon in the southern region to the northern area where it's temperate. Neighboring counties are China, Nepal, Afghanistan, Pakistan, Bhuna, Myanmar, and Bangladesh. (Topography of India)

Figure 1: India's Geographic Location and Neighboring Countries



Population

As of July 2009, the Central Intelligence Agency estimated the population of India to be 1,156,897,766 people. Those who were 14 years of age and under made up 31.1 % of India's population. 63.6% consisted of people in the range of 15-64 years of age. The last 5.3% of the population were 66 years of age and older. The

average age of India's population is 25.3 years. The average age for population of males is 24.9 years and their life expectancy is 65 years of age. The average age of females is 25.8 years and they have the life expectancy of 67 years of age. The estimated GDP work distribution of India is: 17.5% in agriculture, 20% in industry, and 62.6% in services: (Central Intelligence Agency – The World Fact Book)

Sustainability

The form of sustainability labeled as 'green' has been defined country wide through the spread of the Green Revolution. As mentioned on India one stop website, there are three major concepts that contribute to creating the definition 'green'. One component of the green revolution is to keep expanding areas of farmland. Within existing farmlands, double cropping was highly encouraged as an additional component of the green revolution. Implementation of seeds with genetic improvements was another push to making India even more 'green'.

Historical Production

Previously, plowing in India was all done by the labor of bulls. Until the Green Revolution soils were fertilized with cow dung. Due to the influence of the Green Revolution, production yield has been improving greatly. Before the push of the different ideologies of the Green Revolution, "The history of organized vegetable seed production in India goes back to the period of Second World War. Prior to this temperate vegetable seeds were mostly imported from Europe. The

Kashmir valley was developed for the production of vegetable seeds in the forties."(Chaudhury, N/D)

Current Production

Floriculture production in India covers about 34,000 hectares of land. Out of the 34000 hectares, as stated by Indiaagronet.com, the 24,000 hectares comes from traditional flowers such as marigolds, floricultural land. The additional 10,000 hectares of floriculture crops consist of carnations, roses, gerberas, anthuriums and other ornamental flower types that are referred to as traditional. On the APEDA website it states that "In India, Maharashtra, Karnataka, Andhra Pradesh and Haryana have emerged as major floriculture centers in recent times. About 160.7 thousand hectares area is under floriculture at present. Production flowers are estimated to be 870.4 Mt of loose flowers and 43417.5 million of cut flowers in 2007-2008" (APEDA) . The major countries that India exports floriculture products to are: USA, Germany, Japan, UK, and the Netherlands.

"India is ranked as second in the world production of fruit as well as vegetables" (Horticulture for Sustainable Income and Environmental Protection) For fruit production, mangos are the top produce grown. About 8.55 million tons of mangos are produced in India on over a million hectares of land. The second largest crop is sugar cane. Other major contributors to the fruit production include; oranges, apples, limes, litchis, papayas, pineapples, and bananas. Apple production reaches over 12,000 hectare. The most important vegetable crops are tomatoes, okra, hot peppers, and eggplant.

Production Practices

Hi tech horticulture and precision farming are two of many production practices that have been implemented in India.

- "Hi-tech horticulture is the deployment of modern technology which is capital intensive, less environment dependent, having capacity to improve the productivity and quality of produce. Hi tech horticulture encompasses a variety of interventions such as micro irrigation, fertigation, protected/greenhouse cultivation, soil and leaf nutrient based fertilizer management, mulching for in situ moisture conservation, micro propagation, biotechnology for germplasm, genetically modified crops, use of biofertilizers vermiculture…ect"(Horticulture for Sustainable Income and Environmental Protection)

  Precision farming is described as the mechanisms that "involve the application of technologies and principles to many spatial and temporal variability associated with all aspect s of horticultural production for improving crop performance and environment quality".

Most of India's horticulture production isn't done in controlled environments such as greenhouses. A lot of it is done in the field. Growing structures such as greenhouses, cold frames and other controlled environments tend to be used in order to be able to do production of crops outside of regular season. Some of the top crops exported by India are apples, bananas, mangoes, oranges, and apricots.

India's tropic and sub-tropic climate is capable of sustaining crops for the most part year long out in the fields. So greenhouse production, low tunnels, and high tunnels aren't significant or huge contributor to India's horticulture production practices. Some greenhouse production still occurs. For field production there are numerous current practices that India uses to produce the most and best quality fruits.

Yield Increase

For increasing the yield of mangoes, mango trees are sprayed two times during bloom with 10-12% urea at fertilizer grade. This element in production almost lessens completely a bad crop that would have occurred during the rainy season. This treatment also promotes higher yield during the summer season up to 3-4 times. Another method that helps increase yield that is done in India is to mulch with a combination of coconut leaves, either green or dried up. A sustainable way of using fertilizers for yield increase is to use a weaker dose of fertilizer than recommended. Using at least 50% strength can produce the same amount of yield as full strength mixtures.

Density

Planting some crops in India at higher densities actually produce a higher yield. Fruits common in India that benefit to higher densities are bananas, papaya, and Nagpur.

Insects Riddance

In some parts of India sweet potato weevil is managed by using braconid parasitoid. A very sustainable method of dealing with of fruit-borer is having a trap crop of marigold intercropped among tomatoes. Similarly, mustard can be grown as a trap crop for cabbage to help avoid diamond back moths infecting and destroying cabbage.

Water Management

Drip irrigation has the benefit in several crops such as watermelon, tomatoes, and brinjal to increase yields up to 33%. Irrigating through drip irrigation goes directly to the soil, so the least amount of evaporation occurs.

Integration of Production

Now-a-days machinery has taken over a lot of the labor force in farming. The plowing that used to be done by bulls is now done by tractors. Being green has differed since the term first came out. Right now being green in the horticulture sense means farmers are using organic methods and are pesticide free in their production. Being 'green' back in the in the Green Revolution during 1960s and 70s alluded to that "if farmers embraced chemicals and high-yield seeds, their fields would turn lush green with crops." The natural disposal of cow dung used to be common way of fertilizing. Before hi-yield seeds came farmers were growing traditional seeds that didn't require additional irrigation besides the natural rain fall of India. With the new innovative seeds, they required a lot more water to grow healthy which means that additional irrigation from the groundwater is needed. This in fact causes problems with India's accessibility to the ground water. The more

and more irrigation from the groundwater occurs the deeper the ground water level will be, making it harder to access.

Production Practice Ranking

The production forms mentioned earlier in the current production have varying benefits and disadvantages. To illustrate these differences, Table 1 shows these production forms rankings according to efficiency, Environmental Factors/ Effects, time consumption. In the efficiency category, the higher the number the more efficient the process is. A high score in the Environmental Factors/Effects denotes that the effects aren't harming to the environment, they actually have a positive impact to the environment. For Time Consumption category, the higher the value the least amount of time or effort it will take. The higher total value denotes higher levels of sustainability.

Table 1 – Ranking of Practices of Production in India.

Production form	Efficiency	environmental factors /effects	time consumption	total
Plow with bulls	works, possibly hard to manage bull, very laborious 2	Bulls can tear up land in unwanted ways 3	Very time consuming 2	7
Plow with tractors	hardly effortless 4	Exhaust disposal 1	Labor time lessons 4	9
High yield seeds	Larger yields at harvest 4	Ground water lowered, require a lot of irrigation 1	Consuming if rainwater isn't readably accessible 2	7
Drip irrigation	Least amount of water loss 4	Water gets directly to soil, evaporation minimal 5	Automatic 5	14
Trap crops	Attracts targeted insects elsewhere 4	Natural elements are used 5	Additional planting and planning is needed 4	13
Full strength fertilizers	Provide lush growth 4	Run off, build up of salts 2	Pay attention to plants to if any ill effects occur 2	8
Half strength fertilizers	Growth can be just as lushes as full strength fertilizers 3	Build up of nutrients happens at slower rate 3	Don't need to be as worried if over applying 3	9
10-20% urea spray	Yield multiplies 3 to 4 times 4	Drifting and may affect neighboring crops 2	Time is well spent harvesting good fruit 3	9
Mulching with coconut leaves	Additional organic matter is added to soil to make it healthy 5	Very researchable, organic matter high in nutrients 5	Leaves need to be chopped before it gets laid on, possibly composted 4	14

Research needs

A lot of mango plantations spray their mango trees to promote blooming and ripening of fruits. Not a whole lot of other methods that don't require chemicals to get the same results are known to be used out in the field. So further research needs to be made so sustainable methods can be implemented throughout the whole entire growing seasons of mango production. Additional research can be done to see with good drainage area if mangoes could still be grown in areas of India that get a lot of rainfall yearly.

Sustainability challenges

Numerous challenges arise with sustainability methods. One major challenge is to truly stay sustainable. If an outbreak of insects comes to infect a mango grove, it's a lot easier and less time consuming to do a mass spraying with a chemical that will for sure eliminate the pest with one or just a few applications, than have to manage with IPM practices. IPM practices can be as effective as traditional methods of dealing with insects, but it takes consistent effort to act early on the problem and to continue on with IPM measures so damages don't happen to the mango trees that can't improved.

Research Potential and Questions

Mangoes are a well suited crop for further development of becoming even more sustainable. “Mangos can be grown on a wide range of soil types, from light sandy loams to red clay soils” (B.Choudhury, N/D). So soil type won’t be a factor that limits or restrict mangoes to being able to grow only in a small region. As India’s major crop, mangoes are grown and produced throughout numerous areas of India. The areas that mangoes aren’t well suited for are areas that are really wet that receive more than 60 inches of annual rainfall. Elevation levels are another factor that limits the possible areas that mangoes could be grown abundantly. Some questions that needs to be considered are: Do mangoes have a potential to grow and produce a good yield in areas that receive more than an annual 60 inches of rain? Can mangoes be efficiently grown in higher altitudes than 1200m?

Experiment Facilities

To experiment with different sustainability practices with mangoes, a few sites would be great. One area would be outside of the ideal elevation of where most mango plantations are grown. The other cite would be a region in India were it gets a lot of rain, more than 60 inches of annual rainfall. Chemicals are often used to induce and further the process of mangoes to bloom and ripen. At the two facilities other methods will be used to induce flowering and ripening of fruits that is more sustainable.

Proposed Experiments

To test out the first facility, a group of mango trees will be grown at various elevations to see if the ideal range of mangoes could be expanded and to see the effects that higher elevations has on the growth and development of mango trees. One grouping of 30 mango trees will be planted at 1200, another 30 mangoes at 1400, 1500, and 16,000. At this facility pesticides won't be used; Integrated Pest Management will be implemented instead. So this site and the other site will asses if it is economically beneficial to have mangoes grown completely sustainable. Yield and quality of fruit will also be examined.

For the second site sets of 30 mango trees will be planted in areas that get an annual rainfall that differs. So one set will be in an area that receives 60 inches of annual rainfall. Other sets will receive 70, 80, 90, and 100 inches of annual rainfall. The mangoes for these sites will be planted on a slope so the mango trees don't have to be sitting in water. This will also promote better drainage that mango trees require. Like the altitude facility a totally sustainable methods will be used during the growing process of this experiment

Duration

These experiments will be tested for a 5 year period. Throughout the whole period all the mango trees will be fully developed and mature. The 5 year span will be ideal to help trouble shoot and solve problems that may occur during the first few years. This way by the end of the few years that's left of this experiment, IPM practices would be well on its way of being implemented and beneficial. A better

study of comparison and statically analysis can be made with the duration of 5 years.

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