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### RESEARCH ARTICLE

#### DIVERSIFIED FARMING OF SUGARCANE AND PULSES: AN ACCESS TOWARDS MAINTAINING YAWNING PRODUCTIVITY GAPS AND SECURE FOOD FOR INDIA.

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#### Abstract

There has been a wrong notions that pulse crops are meant for the poor and marginal lands. But scientists have demonstrated that with the available technology adoption, the yield of pulses as well as sugarcane could be considerably increased depending on the situation, varieties and improved technologies. Pulses have very good opportunity to find place in different agro-ecosystems. Now-days, soil organic carbon and crop productivity have become major concern in sustainable agriculture. From 1980 to 2016, the total cropped area of pulses in India increased from 22.46 to 26.40M ha. Due to stagnate in production and an increase in population, the per capita availability of pulses and sugar have been declined during 2009-2015. In 2016 production of pulses and also sugar have increased providing pulse 47.23 g/capita/day and sugar 23 kg per capita annually. Significant enhancement in area and productivity of pulse is possible by growing as intercrop with sugarcane crop which is grown in more than 5.15 million ha area in the country. Thus there is a great scope of increasing area under pulse through crop diversification /intensification .Adoption of pulse crops with autumn (October) planted cane in furrow-irrigated raised bed system with 90cm row spacing of sugarcane planted in furrow/trenches and component crop is on raised beds/spaces between two trenches. This approach also provides great scope for increasing crop yield and optimizing input use efficiencies in the system. Crop residues recycling of pulses addresses the key issue of decreasing soil organic carbon created due to indiscriminate use of fertilizers and lower use of organic manures. Mechanization of diversified cropping system will certainly boost the adoption of recommended technologies by the farmers, Thus cost of production could be reduced and profitability may be increased with introducing these crops in irrigated agro-ecosystem with improving soil fertility and food security in sustainable way for longer period.

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### Introduction:-

The Indian agriculture as a whole is undergoing several transformative changes. Growing population changing lifestyle, expanding urbanization and accelerating climate changes are creating new challenges on national agricultural research and development. Green revolution led to quantum jump in food chain production from 51 million tonnes in 2013-14. The area under rice and wheat which was 36.94 and 14.99 million ha in 1967-1968 gone upto 43.9 and 14.99 million ha in 2013-2014, respectively.

By virtue of their adverse nature with respect to duration, adoption to different climate and other nitrogen associated benefits pulses are the integral part of the different cropping systems of the country. Their versatile nature makes them ideal components in crop diversification and intensification. Pulses contain 22-24% protein which is about 2-3 times more than the wheat and rice, respectively. The major pulse crops grown in India are chick pea, mung bean, urd bean, lentil, pea and lathyrus (Singh, 2015).

India is the largest producer and consumer of the pulses in the world. India contributes about 24% of the total pulses production globally. The main pulse producing states are Madhya Pradesh, Rajasthan, Maharashtra, Uttar Pradesh, Karnataka and Andhra Pradesh with an average area of 20.13, 16.40, 13.80, 9.5, 9.3 and 7.9%, respectively to the total pulses area of the country. Among the pulses, chickpea contributes major share in the pulse basket of the country with about 48% followed by pigeon pea (15%), mung bean and urd bean (7% each), lentil and field pea 5% each.

The value of pulses as intercrop in sugarcane could be recognized from the fact that they supplement nitrogen, suppress weeds, improve soil properties and sustain plant ratoon system. Garside and Bell (1999) concluded that well managed legume crops are best adopted to play an important role in sugarcane based cropping systems. Intercropping of pulses in sugarcane add substantial quantity of nitrogen through mineralization after incorporation of the stalks of intercrops (Prakash and Hunsingi, 1994). Moreover, intercropping of winter pulses is tool to promote autumn planting of sugarcane giving 15-20% higher cane yield and 0.5 units more sugar recovery than spring planted cane. On the other hand, intercropping of mungbean / cowpea in spring planted cane can bring an additional one million hectare area under pulses in northern states with their increased productivity because of high yielding irrigated environment.

**Table1:-** Growing population and estimated sugar consumption in India

| Year | Population in millions |                   | Sugar consumption (m tonnes) |                   |
|------|------------------------|-------------------|------------------------------|-------------------|
|      |                        | @ 20kg per capita | @ 30kg per capita            | @ 40kg per capita |
| 2010 | 1180                   | 23.60             | 35.40                        | 47.20             |
| 2030 | 1470                   | 29.40             | 44.10                        | 58.82             |
| 2050 | 1757                   | 35.10             | 52.71                        | 70.28             |

### Sugarcane Scenario in the world:-

Sugarcane was considered as rare commodity and it was used as medicine rather than as sweetener. Globally it is an integral part of food to provide energy. Carbohydrates such as starch, sugar and polysaccharides are essential components in the human diet (Blume, 1985). Sugar is today regarded as a mass consumption item and is also accounts for a large share of the total calorie intake of an average household (Pruthi, 1995). Worldwide per capita sugar consumption reached the equivalent of an energy intake of more than 837 kJ (kcal) daily (Hagelberg and Harris, 1976). Presently, the sugarcane crop provides the third highest quantity of human consumed plant calorie (152 Kcal/capita/day) following rice (533 Kcal) and wheat (530 Kcal) as reported by Moore *et.al.* (2014). Consumption of sugar has increased remarkably, faster than the growth of the world's population. Presently, it has gone up to 171 million tonnes (2015) and annual per capita consumption has risen to the level of 23 kg/year (2015). India is second largest producer of sugarcane (18.18%) and sugar (15.81%) next to Brazil. Out of 101 sugarcane producing countries, top ten countries contribute 81.47% in area and 82.85% in production of world. Top ten cane yield (t/ha) producing countries are Peru (133.72), Ethiopia (119.57), Egypt (115.33), Senegal (114.10), Malawi (107.41), Zambia (102.56), Burkina Faso (102.13), Guatemala (100.69) and United Republic of Tanzania (100.00) and Nicaragua (98.18) but these countries contribute only 2.59% in area and 3.97% in production of the world total of sugarcane.

**Table 2:-**Top five countries in sugarcane area, production and yield (2016).

| Rank | Area wise |            | Production wise |                | Yield wise |              |
|------|-----------|------------|-----------------|----------------|------------|--------------|
|      | Country   | Area (mha) | Country         | Production(mt) | Country    | Yield (t/ha) |
| 1    | Brazil    | 10.44      | Brazil          | 737.16         | Peru       | 133.72       |
| 2    | India     | 5.10       | India           | 362.33         | Ethiopia   | 119.57       |
| 3    | China     | 1.75       | China           | 126.00         | Egypt      | 115.33       |
| 4    | Thailand  | 1.35       | Thailand        | 104.00         | Senegal    | 114.10       |
| 5    | Pakistan  | 1.17       | Pakistan        | 67.46          | Malawi     | 107.41       |

**Source:** FAOSTAT (2016), website- faostat.fao.org

**Sugarcane Scenario in India:-**

There are two distinct zones for sugarcane cultivation in India: Tropical and subtropical. Subtropical north zone while comprising 56% area contributes only 47% to total cane production at the national level. The lower cane productivity (62.26 t/ha) in the subtropical zone as compared to tropical zone (81.75 t/ha) is caused by imbalances in area and production between the two zones.

In 65 years, from 1950, if we take the lowest and highest values in area, production and yield then the picture will be clear. In area, lowest (1.41 mha) and highest (5.15 mha) were recorded in 1953-54 and 2006-07 years respectively. In other words, area increased nearly by four fold.

**Table 3:-** Lowest and highest values (years) for area, production and yield India since, 1950

| Particulars         | Lowest  |       | Highest |        |
|---------------------|---------|-------|---------|--------|
|                     | Year    | Value | Year    | Value  |
| Area (mha)          | 1953-54 | 1.41  | 2006-07 | 5.15   |
| Production (mt)     | 1953-54 | 53.85 | 2011-12 | 361.04 |
| Productivity (t/ha) | 1952-53 | 35.80 | 2011-12 | 71.66  |

**Source:** <http://eands.dacnet.nic.in>

Table 3, clearly shows that lowest production during 1953-54 (53.85 mt) and highest production during 2011 – 12 (361.04 mt) were obtained with six times increased production. In productivity, lowest (35.8 t/ha) and highest (71.66 t/ha) were recorded in 1952 – 53 and 2011-12 years, respectively. So productivity was doubled during last six decades. It is also clear that production was more led by area rather than productivity. In order to meet the growing demand of sugar and energy by 2050 in India, around 630 mt of sugarcane with a recovery of 11.5% would be required of the total sugarcane produced, 70% would be crushed for white sugar, 20% for gur and khandari and remaining 10% for seed and other purposes. According to estimates of the National Commission on Agriculture (NCA 1976) and by various agencies, the population of the country is expected to be 1.65 billion by 2050.

**Sugarcane scenario in states:-**

Among the states in India, Uttar Pradesh leads with 21.60 lakh ha, followed by Maharashtra (9.878 lakh ha), Karnataka (4.0 lakh ha), Tamil Nadu (2.63 lakh ha). Production wise, U.P. leads with 133.20 mt followed by Maharashtra (75.09 mt), Karnataka (34.20mt), Tamil Nadu (27.62 mt), Bihar (14.24 mt). Yield wise west Bengal leads with (115.0 t/ha) followed by Tamil Nadu (105 t /ha), Karnataka (85.5 t/ha) and Andhra Pradesh (79.4 t/ha ).

**Table 4:-** Top five states in sugarcane area, production and yield in 2015 -16

| Rank | Area wise     |                | Production wise |        | Yield wise    |        |
|------|---------------|----------------|-----------------|--------|---------------|--------|
|      | State         | Area (Lakh ha) | State           | (mt)   | State         | (t/ha) |
| 1    | Uttar Pradesh | 21.60          | Uttar Pradesh   | 133.20 | Uttar Pradesh | 115.0  |
| 2    | Maharashtra   | 9.87           | Maharashtra     | 75.09  | Maharashtra   | 105.0  |
| 3    | Karnataka     | 4.00           | Karnataka       | 34.20  | Karnataka     | 91.50  |
| 4    | Tamil Nadu    | 2.63           | Tamil Nadu      | 27.62  | Tamil Nadu    | 85.50  |
| 5    | Bihar         | 2.58           | Bihar           | 14.24  | Bihar         | 79.40  |

**Sources:** Cooperative Sugar (2016)

**Prospects and Hope:-**

Sugarcane being a long duration and bio mass – accumulating crop removes substantial amount of plant nutrients from the soil. Sugarcane crop of 100 t/ha exhausts 250 kg N, 55 kg P and 275kg K besides 3.5 kg Fe, 1.2 kg Mn, 0.6 Kg Zn, 0.2 kg Cu and 30 kg S. However, sugarcane per se adds biomass in the soil including root biomass, stubbles and cane trashes.

Since, nutrients absorbed by cane plants from soil do not form the constituents of its marketable commercial product ‘sugar’, there is good opportunity of organic recycling in this crop. The microbial population in the sugarcane rhizosphere ranges from  $10^5$  to  $10^6$  counts  $g^{-1}$  root tissue.

Andrews and Kassam (1976) have analysed the prospects of intercropping and stated that world food supply through intercropping in developing countries must be seen in prospective, i.e., it is the only one element that fights against poverty. The researches on intercropping have confirmed that small farmers in developing countries like India have been doing and generally provides yield advantage as compared to sole cropping (Willey 1979). Numerous workers (Webster and Wilson 1966; Walters, 1971; Enyi, 1973) have stated that the more complete cover provided by intercropping reduces weed growth by competition. This results in the reduction in labour requirement for weeding. Moody (1976) observed that the growing of intercrops in close proximity to one another results in greater competition against weed and thus reduces the need for weeding. Attempts have been made to change the geometry of planting in favour of growing inter crops. The profits in inter cropping with different intercrops have ranged from 12 to 34% (Lakshmiathan 1983). There is tremendous scope of increasing area under pulses through intercropping in sugarcane under Indian tropics and subtropics.

**Table 5:-** Effect of pulses as intercrop with sugarcane on system productivity (Source: Sharma *et. al.* 1992).

| Cropping system       | Cane yield (t/ha) | Inter crop yield (q/ha) | Sugarcane equivalent yield (t /ha) |
|-----------------------|-------------------|-------------------------|------------------------------------|
| Sugarcane sole        | 81.00             | -                       | 81.00                              |
| Sugarcane + Field pea | 80.34             | 6.20                    | 92.09                              |
| Sugarcane + Rajma     | 78.14             | 7.20                    | 99.85                              |
| Sugarcane + Chickpea  | 77.58             | 11.40                   | 96.11                              |

The compatibility of pulses as intercrop in sugarcane for enhancing system productivity has also been documented (Table 5). The compatibility of intercrops varies with the row arrangements (Yadav *et al*, 1987) and genotypes selected as intercrop in the system (Menhi Lal *et. al*; 2000).

**Effect of system on cane juice quality parameters:-**

As regards sucrose content in cane juice, the different intercrops had no significant effect on juice quality parameters. These results are in line with those reported by Rathi and Singh (1979), Nazir *et al*; (198), Shukla and Pandey (1999) and Li *et al*; (2011).

**Conclusions:-**

Pulses have very good opportunity to find place in different agro- ecosystems. Since last six decades in India, enhancement in productivity of most of the field crops has been obtained but much success could not be achieved in increasing area and productivity of pulse crops. Significant increment in area and productivity of pulses crops is possible by intercropping of these crops with sugarcane. There is great scope of increasing area under pulses crops through crop diversification besides improving their productivity.

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