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SUSTAINABLE INTENSIFICATION OF CROP-LIVESTOCK PRODUCTION SYSTEM IN BIHAR – A REVIEW

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ABSTRACT

Crop-livestock production is a form of land use system whereby livestock husbandry and cropping are practiced in association. The production system safeguards ecosystem balance and assures sustainable production; besides, the production system does not impact on the environment negatively. The burgeoning human population globally has increased the spate of food insecurity and malnutrition especially in the Bihar. There is therefore an urgent need for a better, efficient and sustainable production system capable of providing both crop and animal products for the teeming human population. Crop-livestock integrated production system seems to provide opportunity for the production and supply of food of both crop and animal origin without detrimental impact on the fragile environment. Bihar is a typically risk prone state where occurrence drought and floods are not uncommon. This year, nearly 0.5 Mha area in the state is affected by floods while 2.4 Mha is affected by drought. Under such situations dependency on livestock for livelihood security is high. Therefore, the crop-livestock interaction is very strong in the state. The reduction of high input use with relative increase in crop yield is the major concern. The objective of this study is to view the role of the sustainable agriculture intensification in relation to crop production and achievement of food security. In this paper, we will explore the ways in which sustainable intensification interventions can be carried out. Sustainable intensification could be the better means to minimize the crop yield gap without environmental burdens, a major challenge of agriculture for this era. In this integrated system, crop and livestock interact to create synergy that allows ecosystem balance and sustainable production intensification.

***Key words :** Conservation agriculture, climate change mitigation and adaptation, integrated production system, livestock and rainfed systems.*

Bihar, an agrarian state, with a population of 103.8 million, is the second most populous state in the country. The population density of the state is 880 persons per sq km compared to 340 persons per sq km for the rest of India. About 76 percent of its population are engaged in agricultural pursuits though the share of agriculture in state's gross domestic product is 42 per cent, attributable to agriculture still being at subsistence level with little commercialization. Nearly 92.5 per cent of 16.4 million land holdings are fragmented, small and marginal which belongs to 88 per cent of the farmers of the state. The prominent crops are rice, wheat, maize, and lentil with average yields of 1.5, 2.14, 2.85 and 0.86 t/ha, respectively. About 33.51 lakh hectare net area and 43.86 lakh hectare gross area receive irrigation from different sources. Even though the state is rich in soil and water resources, the average yields of rice, wheat, maize and pulses in the state are only about 32, 44, 40, and 38 per cent of their potential yields; largely attributed to the incidence of abiotic stresses, especially in the rainfed areas. Similarly horticulture is another focussed area in the state. Although, horticulture (fruits, vegetables, tuber and mushroom, spices, honey, medicinal and aromatic plants) occupy 12 percent of land area but income realisation is much higher and per ha productivity is also higher than the other field crops.

The key production system constraints are seasonal floods and droughts complicated with biotic stresses, degrading soil health and emerging multi-nutritional deficiencies. About 40 percent of the total cropped area in the state is flood affected with limited scope for improvement in yield due to water logging during rainy season poor drainage and water management. Similarly nine districts in the southern part of state is recurrently suffering from drought. On top of that, impact of climate change on agriculture is now a reality and without adequate adaptation and mitigation strategies, food insecurity and loss of livelihoods are likely to exacerbate. Climate change is increasingly impacting agriculture in a number of ways. Most importantly, warmer winters and extended summers with altered rainfall patterns are adversely affecting the soil moisture and irrigation water availability. The exact manner in which agriculture will be impacted in this region is uncertain, however, the broad indications are that frequent and longer dry and warm spells will reduce crop yields and adversely impact the health and productivity of livestock. Similarly increased frequency of torrential rainstorms could accelerate resource degradation and result in frequent flooding. Therefore, there is an urgent need to focus on rainfed agro-ecosystem of Bihar and develop resilient crop cultivars by conventional breeding and modern approaches, evolve crop and soil management practices to maximize their production potential, improve quality of natural resources, and adapt production practices to changing climatic scenario for annual crops, horticultural crops and livestock.

The Production Constraints in Bihar : Bihar lies in the eastern Indo-Gangetic plains of India. The site is divided by river Ganges into two parts, the north Bihar with an area of 53.3 thousand square km and the south Bihar having an area of 40.9 thousand square km. The state is divided in to four agroecological zones based on soil characterization, rainfall, temperature and terrain. These are: Zone-I, North Alluvial Plain; Zone-II, north East Alluvial Plain; Zone-III A South East Alluvial Plain and Zone-III B, South West Alluvial Plain,. As agriculture practice is sensitive to agro-climatic conditions, one also find great variation across the zones, in terms of land utilization, cropping pattern and cropping intensity. While agriculture is extensive in the north western part of the state its expansion in the south eastern part is relatively lower.North eastern part of the state receives the highest and earliest rain,while souther part recieves less rains(<1000mm). Eight major river basins-the Ghaghra, Gandak, Burhi gandak, Baghmati, the Adhwara group of rivers, Kamla, Kosi and Mahananda spread across north Bihar. Most of them originate in Tibet or Nepal erode the soil depositing it in the Bihar plains before flowing into the river Ganges. Delta created by the sediments often provoke the rivers to meander and flood the planes. Shifting courses leave behind *Chaurs* (huge land depressions). Similarly, *tals* which remains flooded during summers and farmers grow mostly pulses like lentil and chickpea during winter.The agricultural sector in Bihar is characterized by the predominance of small and marginal farmers tilling more than 62 per cent of the total operated area of Bihar. In Bihar, 94 percent farmers are marginal and small and 44 per cent population in Bihar lives below poverty line. The average size of holding here is less than one hectare. Since the scope for bringing more area under cultivation is limited therefore, emphasis needed mainly on increasing the productivity of different crops by using resilient cultivars, quality inputs as well as improved packages of practice.

Cropping Systems : The primary cropping system in Bihar is Rice-Wheat, Maize-Wheat in agro ecological zone-1, Rice-maize in zone II and Rice-wheat, Rice –lentil, Rice fallow in zone III. Cropping intensity in Bihar is 142%, which fluctuates with the patterns of monsoon. In Bihar, frequent floods especially in northern part of Bihar and drought make rainy crop more risk prone. Natural Calamity (Drought and Floods) takes a heavy toll on agriculture in Bihar. While 7 districts out of 38 suffer from drought every year, rains and overflow of river flood 27 others in Bihar. About 56.5 % of flood affected people in India live in Bihar state only. Farmers grow rainy crops especially rice mostly rainfed situation. Farmers don't use much of external inputs in these crops due to risk of crop failure in flood or droughts.

(i) Rice : Rice being most important crop grown over 3.35 Mha in Bihar, it is mostly grown as rainfed. Poor rice yield in Bihar is mainly due to its late planting due to (i) non-availability of water supplies and labour, and (ii) excessive preparatory tillage operations and customary practice of puddling before transplanting. These situations often force farmers to depend on monsoonal rains and consequent delays in transplanting / seeding operations. Nearly 40% of the total precipitation received during the monsoon season is used in seed bed growth, preparatory tillage and puddling before actual transplanting of the rice nurseries into the main fields. This often leads to terminal water stresses and consequent low productivity of rice. Biotic constraints like sheath blight, blast (disease), gall midge, stem borer and leaf folder (pest) also cause yield penalty in rice. High weed pressure, poor weed management practices are apparent in rice.

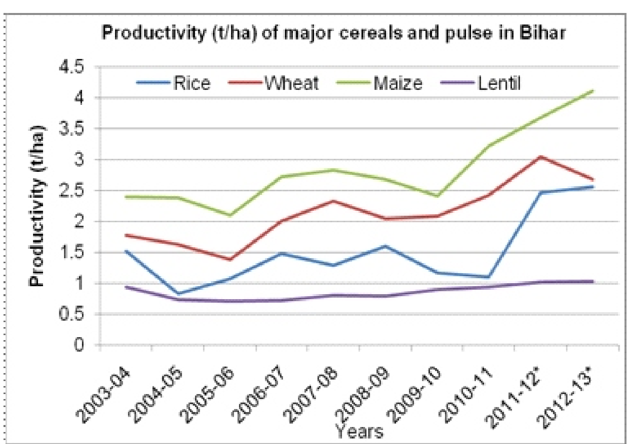
(ii) Wheat : Wheat being second important crop grown over 2.2 Mha in Bihar with an average productivity of 2.12 t/ha. Delayed planting of wheat after late harvesting of long duration rice or photo sensitive rice varieties is the main bottleneck in harvesting higher yield of wheat in Bihar. Consequently, narrower winter window causing terminal heat stress at grain filling stage in wheat. Farmers also avoid irrigating their wheat crop during grain filling which affects grain development and yield adversely. Further, foliar diseases in relatively warm and humid springs also cause yield penalty. Weeds mainly broadleaved and sedges cause severe loss to the wheat crop. Widespread deficiency of micronutrients in sandy soil particularly boron is also appearing in the north-eastern part of state.

(iii) Maize : Maize is one of the emerging and important cereal crops with wide adaptability to diverse agro-climatic conditions in Bihar. Maize is grown on 0.64 Mha with a total production of 1.76 MT and an average productivity of 2.74 t/ha. Maize based systems are gaining importance in view of changing resource base and production practices under the changing farming scenario, thus maize based cropping systems becoming popular among farmers. Maize- wheat, Maize-maize and potato+maize inter cropping systems are popular in Bihar in zone I, while Rice maize system is picking up in zone II. Normally local varieties of maize grown during summer season are rainfed which results into lower productivity whearas in winter/spring season farmers grow hybrid maize with ensure irrigation and high input levels resulting in higher yields. Water logging in Kharif maize, cold stress in winter maize and terminal heat stress in spring maize is the key production system constraint in maize.

(iv) Lentil : In Bihar lentil is grown over 0.193 Mha with 0.178 MT production and 0.84 t/ha productivity. It is grown in rainfed rice field and also in *tals* after flood recedes. Excess soil moisture at planting, rust, *Stem philium* blight and terminal water stress coupled with heat is key production system constrain in lentil. There is immense possibility of vertical and horizontal increase of lentils production in Bihar.

Bihar is a typically risk prone state where occurrence drought and floods are not uncommon. Year by year, nearly 0.5 Mha area in the state is affected by floods while 2.4 Mha is affected by drought. Under such situations dependency on livestock for livelihood security is high. Therefore, the crop-livestock interaction is very strong in the state. On other hand crops like rice, wheat, maize and lentil contribute more than ninety percent of the total food grain production in the state. The productivity of these crops is nearly two tonnes per ha for cereals and less than one tonne per ha for pulses Fig.-1. The yield gap between the attainable yield and the actual yield is 78, 51, 67 and 66 percent for rice, wheat, maize and lentil, respectively.

According to a report of National Rainfed Area Authority of India (NRAA, 2009), there is an increasing concern for decelerating growth rate in Net State Domestic Product in rainfed agriculture, that has decreased from 4.01% in 1985-1995 to -0.14% during 1995-2004, whereas the deceleration in growth rate of irrigated agriculture has been meagre, i.e. 2.9 to 2.07 %, in the same period. The rainfed ecology in state has emerged as a highly challenging environment, in which increasing crop productivity, reducing cost of production, and restoring degraded natural resources while keeping pace with climate change occurrences are critical elements in reducing extreme poverty and improving livelihood in this region. The major concerns of rainfed fragile environments are soil erosion and vulnerability to degradation, low organic matter, poor



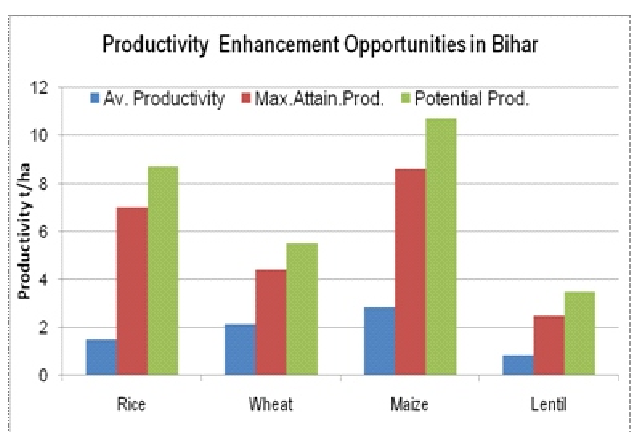


Fig.-1 : Average productivity and opportunities of productivity enhancement in Bihar of key commodities. (*estimated values).

soil fertility, water stress, loss of biodiversity, non-availability of suitable crop varieties, classical practices of soil and crop management and more pressure of livestock on pastures due to fodder shortages. These are the major factors responsible for less crop productivity that eventually affects the food and livelihood security in the region.

Therefore, the strategies should focus on, Identification and development of climate resilient genotypes of Rice, wheat, maize, chickpea and lentils by evaluation, breeding and use of modern techniques. The resilient genotypes will be tested under participatory breeding for adaptation, before dissemination. Similarly, Conservation agriculture based crop management for important crops and cropping systems is recognized to reduce climatic risks, produce more crop at less cost and less emission of green house gasses. There is thus an urgent need to focus on rainfed agro-ecosystem of the state and develop CA based crop and soil management practices such as to maximize their production potential, improve quality of natural resources, and adapt production practices to changing climatic scenario. Since, floods, drought and climate risks (heat, cold) are frequent in Bihar, therefore, situation specific contingent plans for crop and livestock production will be developed, validated and rolled out in the selected sites in the Bihar. Since availability of the seeds of component crops in the contingent plan is always in question for that reason .Moreover, identify and multiply resilient fruit trees for wider adoption, in order to improve the nutrition and alternate income to the farmer.On the other hand, livestock is the key source of livelihood in the state, it contribute nearly fifty two percent of the gross domestic product of agriculture sector in the state.; the state owns 272 lakhs livestock, of which 43 lakhs are cattle and 22 lakhs buffaloes (GOI.2006). The acreage under green forage in state is almost negligible (0.21 % of the total cultivable area). Straw availability (kg/adult live stock) is only 3.5 kg against the average requirement of 10 kg. Only large farmers (<5%) grow any fodder, small and marginal farmers (90%) depends on crop residues for feeding the livestock. Further increase in the acreage of the fodder crops is not possible due to increased competition between various land uses for cultivable land. Only way to meet the fodder needs to livestock is to look for increased productivity per unit land area and also through integration of the fodder crops in the cropping system. Therefore, work on standardization of fodder technologies in rainfed ecologies and come up strategies for integration of fodder trees, bushes and associated technologies to produce quality fodder round the year.

Increased adoption of climate smart varieties of rice, wheat, maize and lentil for enhanced farm productivity and profitability : Bihar is predominantly an agriculture-based state. Agriculture influences the socio-economic and political condition in the state. The fluctuation in agriculture production and productivity has a great effect on the masses in Bihar. Therefore, it necessitates maintaining, and further improving the productivity and production to meet their ever-increasing demands. On the other hand, global warming due to climate change develops several types of stress conditions for crops in which abiotic stresses like drought, heat, water logging and biotic stress like insects, pests, fungus, bacteria, viruses etc. These drastically lower down the production and productivity of important crops. To overcome these stress condition by manipulating plant ideotype or improving genetic potential either by selection, evaluation, breeding or biotechnological approaches are necessary. The developments in biotechnology, genomics, and molecular marker applications will be used immensely to complement the classical plant breeding programmes. Further, with the advent of new genomics technologies like next generation sequencing and microarrays for global gene expression analysis besides other “omics” technologies and bioinformatics are proving powerful tools for understanding genome variation, response of various stresses and cellular processes, thereby facilitates devising strategies to mitigate any adverse effect on crops.

As due to climate change, exposure to various abiotic and biotic stresses, are likely to increase the cues, such as temperature extremes (low and high), drought, UV-radiation and pathogens attacks that will lead to enhanced reactive oxygen species (ROS) production. Consequently, it could hamper the production and productivity of many crops (Pretty., 2008). Therefore, the consider a balanced blend of modern technology and old technology to boost crop improvement for securing foods for millions. The augment development of flash flood tolerant rice, drought tolerant rice; terminal heat and drought tolerant wheat (Bread wheat and Durum); Heat and drought tolerant lentil and short duration and heat tolerant maize suitable for Kharif and spring season. It is pertinent to mention that maize is grown on nearly 100 thousand ha in the riverbeds during rainy season which is regularly prone to floods.The state university research is already focussed on developing resilient cultivars of key commodities against abiotic stresses. The rice breeder seed program in university included multiplication of deep water and semi deep water varieties, Janki, Satyam, Sudha and Vaidehi which recently released super fine grain rice variety Sabour Surbhit is adapted well in the drought prone areas of the state. Similarly the university is also working on drought tolerant rice in different projects.

Widespread adoption of conservation agriculture based crop management practices for mitigation and adaptation to climate change : Conservation Agriculture based on the principles of reducing tillage, retaining crop residues and diversified crop rotation is been adopted in many countries prone to Abiotic stresses. In recent research efforts Conservation Agriculture (CA) based crop management have been developed and extended to irrigated production systems in India that have proven to be resource efficient and have helped improve production and farm profitability compared to conventional practices. As an additional bonus, the CA based technologies reduces global warming potential (GWP) compared to the conventional system and help farmers in adapting their crop management practices to likely adverse effects of climate change. There is thus an urgent need to focus on rainfed agro-ecosystem of Bihar and develop CA based crop and soil management practices such as to maximize their production potential, improve quality of natural resources, and adapt production practices to changing climatic scenario. Recently developed early maturing and disease resistance varieties of pulses along with appropriate CA based crop management can fit well in various cropping systems thus increasing not only productivity but also sustaining the cereal-based cropping systems in the long run. Rice-fallow lands can be planted to legumes (lentil, chickpea, pea) using CA based practices. CA practices improve resource use efficiency and provide the strategic platforms for re-introduction of grain legumes into farmer fields (Kassam *et al*., 2009). Zero tillage and surface seeding (tossing the seed on to wet soil surface) offer huge opportunities for relay planting pulse crops in rice fallows. These CA-based technologies are versatile and scale neutral to suit the needs of individual farmers having different resource endowments.However, unless these CA-based crop management technologies are properly developed, tested and fine-tuned with adequate farmer participation before widespread extension to farmers, these benefits might not be equally suitable for all locations and agro-ecosystems. Important variability and system tradeoffs could limit the expansion and adoption of these technologies in smallholdings especially if the CA-based technologies have not been adequately fine-tuned and validated in farmer fields with active farmer participation.

Improved resource use efficiency, profitability and sustainability of the farming system : The productivity of rainfed agriculture in Bihar is abysmally low as the developments in agriculture have been concentrated in irrigated areas. Rainfed farming systems were hitherto dependent on local inputs and withstood drought and flood conditions. But over time, crops in these fragile ecosystems are demanding intensive use of inputs that are difficult to manage using local resources. The increasing area under cereals and decreasing area under pulses and oil seeds is also alarming. The *Tal*, *Chaur* and *Diara* lands, which occupy a large area in eastern India, have their peculiar problems. Drought and flood incidences drastically reduce crop yields. Technologies that reduce the production risk caused by drought will favour input use and have a major impact on system productivity in good and bad years. In addition, improved technologies that reduce labour and land requirements for crops are needed to allow these resources to be released for other income-generating activities. Good opportunities for diversification through post-rice crops are provided by the development of new drought-tolerant, short-duration rice varieties lines such as Sahbhagi dhan, Abhishekh and Shushk Samrat, similarly flood tolerant rice such as Swarna sub-1 is also available. Most farmers practice limited or no cropping during the *Rabi* season in drought-prone areas of Bihar, thus failing to realize the full production potential of their land. New area specific systems need to be developed to improve the post-rice production. Timely and appropriate planting techniques allow earlier-maturing crops, maximizing the use of residual water for post-rice Rabi crops. New, improved varieties of Rabi-season crops, notably pulses, allow for a greater range of options for Rabi season cropping and land productivity. Surface seeding of pulses like lentil into the standing rice crop before harvest is practiced in these areas if sufficient moisture is available. There is a strong need of managing midterm and terminal droughts of 2-3 weeks to have a capacity for intensifying cropping in hitherto single crop situations; more so because of the prevailing low cropping intensity in these areas.A host of practices that aim to increase the infiltration opportunity time, minimize evaporation, decrease soil bulk density and erosion susceptibility, increase the access of the rainfed crops to the stored water and nutrient resources in the lower layers, staggered planting in conjunction with diverse crop rotations, weed management, controlling grazing and human interference and avoidance of terminal heat stress can contribute towards obtaining greater yields from rainfed agriculture on a sustainable basis. However, the effects of each of management option needs to be quantified on a uniform scale for the effects to be additive and comparable. The potential of these options, according to site-specific conditions and needs is being investigated for post rice crops, using seed drills and minimum tillage techniques, wherever they are suitable. There has been further impetus to develop and validate site specific nutrient management tools for water stressed ecologies and efforts are on to develop and strengthen international networks to this end. There is undoubtedly a need for increasing the intensity of these efforts with outreach activities and participatory research for validation and better adoption of the research results.

Increased availability of fodder with appropriate feeding and storage technologies : Crop and livestock are interdependent and represent principal economic output in a farming system of Bihar. Live stock contributes more than half of the total state domestic product of agriculture. Live stock, mainly dairy cattle are the source of income during floods. Similarly, small ruminants mainly goats are reared by the resource poor farmers in drought prone areas. Crop residues provided a large proportion of feed needs of live stock. Under flood and drought feed demand is met by grazing and green fodder obtained by cutting grasses on field bunds or by weeding. Under floods availability of fodder is almost zero because of water all around. We have experienced that the communities move to higher/elevated spots which is out of flood water, these area are marked by communities since generations, in these ecologies perennial fodder trees and grass species eg. Para grass (which can tolerate water logging), can be potential source of fodder. Similarly, the drought prone areas are particularly vulnerable due to climatic aberrations and human pressures, and poverty in all its dimensions. The land degradation in rainfed drought prone area is mainly due to wind/ water erosion by excess grazing. Under such situation we propose integration of multipurpose forage shrubs or trees with crops. These fodder species can potentially release pressure on grazing and crops residues for fodder and part of crop residues can be used for mulching a, basic requirement for adoption of conservation agriculture based crop management. Quality green fodder from shrubs or fodder trees can improve feed quality and yield of live stocks grazing on farm. Additional biomass thus will be available for improving livestock productivity from enhanced crop productivity. These fodder species will also protect crop and soil from runoff and can be used as property demarcation besides providing fuel wood without affecting crop yields. Introduction of fodder shrubs and appropriate trees through germplasm import from various institutions. Appropriate feeding strategies will be developed for utilization of lopping from shrubs/ trees as livestock feed. Promote of pilot community-based micro-enterprises of nursery raising of shrubs and fodder trees. Under this activity the focus on optimization of residue, screening of fast growing multipurpose fodder species tolerant to floods, sources of fodder which are high in nutritional value and biomass, faster in growth, annual/perennial in nature will be identified. Appropriate feeding strategies can be developed for utilizing these species in fodder for improving livestock productivity. Fast growing resilient fodder trees would be identified and tested for compatibility with annual crops. The carbon sequestration potential of promising species will be measure. Following fodder trees and bushes could be promising (Table-1).

Increased nutritional and income security through resilient horticultural crops and associated technologies : In rainfed regions, horticulture helps in diversification, risk mitigation, value addition and enhancing farm income. With the introduction of National Horticulture Mission and Chief Ministers Horticultural Mission, there has been a sharp increase in area under horticulture in rainfed regions. Rainfed eco systems with 700 mm or more annual rainfall have relatively better opportunity for horticulture. The production and productivity of rainfed horticulture mainly depends on the quantum and distribution of rainfall. However, the year to year productivity is also influenced by a number of climate factors like temperature, humidity and extreme weather events like

Table-1 : Prospective alternate sources of fodder for Bihar.

Tree	Description
Gliricidia sepium	Gliricidia leaves contain high crude protein content (21%) with 58 % digestibility, crude fibre upto 68% digestibility and the gross energy value of about 4.35 kcal/g.
Leucaena leucocephala	Leucaena leaf contains 55% total digestible nutrients (TON), 2.42 Mcal/kg of digestible energy (DE), and 1.98 Mcal/kg of metabolisable energy.
Acacia catcheu (Khair)	This tree has medicinal as well as use for fodder purpose
Tamarindus indica	Tamarind foliage, pods, seeds and pod husks are used as feedstuffs. The foliage has a high forage value.
Moringa oleifera	Leaves as a source of proteins, calcium, iron, ß-carotene (converted to vitamin A in the human body), vitamin C and vitamin E.
Dalbergia sisoo	Young branches and foliage form an excellent fodder with a dry-matter content of 32.46%, crude protein 2.7-24.1%. The foliage could be used as emergency feed.
Mores alba (Mulberry)	Leaves contains 15.0% Crude Protein
Enterolobium saman (Rain-tree)	Fodder: Ripe pods have a crude protein content of 12-18% (dry matter) with 41% digestibility for goats, and are popular with cattle, horses, goats and other animals. Although the leaves are nutritious, they are not considered an important fodder.
Bushes/shrubs	
Crotalaria juncea (Sun hemp)	It also serves as a good fodder crop in many parts of the country. Sun hemp dry matter as fodder contains crude protein 14.2%, crude fibre 33.3% and carbohydrate 38.6%.
Sesbania aculeata	Very good protein source for goats, on dry matter basis it contains crude protein 18.7% and crude fibre 35.42%.
Others	
Bamboo leaf (Bambusa spp.)	Crude protein content in bamboo leaves from different cultivars ranges from 14-20.39%.
Banana Trunk & leaf	Leaves and stems are source of good green roughage. Feeding of whole banana plant (stem & leaves) with dry fodder can maintain cattle and buffaloes. Chaffed whole banana plant can be fed to adult cattle along with dry fodder (in 10:1 ratio) for maintenance.

cyclones, floods, hail storms, heat wave and cold wave. Rainfed horticulture also plays a stabilizing role in providing fodder for livestock when practiced as horti-pastoral system. In India, a number of horti-pastoral systems have been recommended which have demonstrated their usefulness both in terms of nutritional security, mango, citrus, guava, custard apple and tamarind are some of the important horticulture crops grown in semi-arid and dry sub humid regions with supplemental irrigation. Similarly crops like guava and jamun (*Syzygium cumuni*) can tolerate some degree of water logging especially in sandy soils. These crops are subjected to high climatic variability particularly the rainfall and temperature in a geographical location apart from extreme weather events.

Development and adoption of dynamic contingent plans in targeted regions : Contingency crop planning requires greater attention through use of resource-conservation technologies and a shift from sole cropping to diversified farming system is highly warranted. The focus must be on mainstream adaptation of policies and actions so as to address the adverse impacts of climate change and reduce vulnerability to changing climate and extreme events.

CONCLUSION

Agricultural intensification has a positive implication on livelihood security in terms of better economic and social conditions, like food security, employment opportunity and improved division of labor; and improved institution. With the application of clever and modern agronomic management and mechanization techniques, crop production can be increased without any problems regarding environment and climate issues. The closeness to the huge yield gap and increase productivity to feed the number of populations in this world, sustainable intensification play a crucial role. Therefore adoption of agricultural intensification leads to the increased agricultural production. It has been found to be a viable option to improve livelihoods context of farmers.

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