International Journal of Advanced Science and Research
ISSN: 2455-4227
Impact Factor: RJIF 5.12
www.allsciencejournal.com
Volume 3; Issue 1; January 2018; Page No. 38-46

An extensive review of effect of diversification and intensification on the yield, physiology and nutrient uptake in the major cropping systems

[1] Deepika Chourey, [2] Jitendra Patel, [3] Artika Singh

[1] Research Scholar, Department of Life science, Pacific University, Udaipur, Rajasthan, India

[2] Research Scholar, Department of Management, Devi Ahilya University, Indore, Madhya Pradesh, India

[3] Research Scholar, Department of Agronomy, College of Agriculture, Indore, Madhya Pradesh, India

Abstract

The immense population growth around the world has put a large pressure on earth for cereal production ever increasing demand of food and climatic change has worsen the situation even more. In this scenario Crop diversification and intensification are feasible solution for growing demand of food and to fight against global warming, with technical advancement in agricultural, crop diversification and intensification are area of growing interest among the researcher. Agricultural scientist and researcher find these techniques especially beneficial to marginal farmers who depend on one or two crop in a season and in development economy where growing population and land productivity remains the critical issue. The present study focuses on different type of crop diversification and intensification technique used worldwide also on different researcher done on above mentioned issue. The present study has extensively review the work previously done on effect of two factors on overall productivity of crop. The present work will prove to be beneficial to the academician and researcher as they will know the amount of work done on the issue as well as new avenue of research, and for policy maker and industry people to know the where to invest to give benefits to the farmers and how the good policy can increase productivity without adverse effect on land.

Keywords: crop diversification, crop intensification, cropping pattern, climatic change, land configuration, economics and energetics

1. Introduction

Crop diversification is intended to give a wider choice in the production of variety of crops in a given area. Depending on just one crop can have grave consequences and leave small farmers open to unnecessary hazards. Crop diversification in India viewed as a shift from traditionally grown less remunerative crops to more remunerative crops (Hazra, 2000) [30]. Natural resource management for sustainable agriculture development is important for India's food and nutritional security. Crop diversification can be a useful means to increase crop output under different situations. Diversification of agriculture in favour of commercial crops leads to greater market orientation of farm production and progressive substitution of non-traded inputs in favor of purchased inputs (Joshi *et al.*, 2002) [37]. Increasing diversification of cereal cropping systems by alternating crops, such as oilseed, pulse, and forage crops, is another option for managing plant disease risk (Krupinsky *et al.*, 2002) [43]. It is a climate-smart agriculture strategy for food security, mitigation and adaptation.

The population of India is continuously increasing (1.27 billion) and per capita availability of land is gradually declining, it would be increasingly difficult to produce enough food for increasing population in coming years (Anonymous, 2013) [5]. Primary constraints in achieving food security are the low yield per unit area, high population pressure, and negligible scope for expansion of the area of land for cultivation. Under these circumstances available options will be crop intensification and diversification through the use of modern technologies. Intensive cropping is the practice of producing maximum yield from given area by growing of two or more crops on the same field in a year. Intensification of crops provides opportunity for optimizing crop production per unit area and time, ensuring food security, self sufficiency, insurance against crop failure and judicious utilization of resources. The intercropping provides higher cash return to smallholding farmers than growing the monocrops (Saleem *et at*., 2011 and Solanki *et al*., 2011) [77, 82]. The legume + cereals is most commonly practiced system of intercropping in which the crop show complimentary effects rather than competitive effects. The system is also economical and viable due to substantial saving of nitrogenous fertilizers applied in cereal crops.

Cropping patterns used on a farm and their interaction with farm resources, other farm enterprises, available technology and environment which determine their makeup, constitute the cropping system. Cropping system research aims at increasing production and farm income in sustainable way making use of the available technology and the physical and socio-economic resources of the farming community (Panda, 2006) [67].

Land configuration is a potential tool for soil and moisture conservation. Appropriate land configuration like broad bed and furrow, ridge and furrow system increases crop yield due to increase in rainfall infiltration into soil profile and it becomes available to the crop during prolonged monsoonal break and controls water crises in agriculture by the way of 'more crop per drop' decrease bulk density and penetration resistance and remove excess water.

1.1 Crop Diversification Definition
Crop diversification means growing a variety of crops in an area, not just one. If one crop fails this year, the area can still survive. Crop diversification refers to the addition of new crops or cropping systems to agricultural production on a particular farm taking into account the different returns from value-added crops with complementary marketing opportunities.

1.2 Crop Rotation Definition
Crop rotation means not growing the same crop in the same place year after year, depleting the soil of the nutrients needed to grow that crop. It should also include letting the ground lie fallow some years to let it recover, or growing crops for the purpose of replenishing soil nutrients.

1.3 Major driving force for adopting Crop Diversification
(1) Increasing income on small farm holdings
(2) Withstanding price fluctuation
(3) Mitigating effects of increasing climate variability
(4) Balancing food demand
(5) Improving fodder for livestock animals
(6) Conservation of natural resources
(7) Minimizing environmental pollution
(8) Reducing dependence on off-farm inputs
(9) Depending on crop rotation, decreasing insect pests, diseases and weed problems
(10) Increasing community food security.

1.4 Factor effecting Crop Diversification
(1) Availability and quality of resources including irrigation, rainfall and soil fertility.
(2) Access to technologies such as seed, fertiliser, water, marketing, storage and processing.
(3) Household related factors covering food and fodder self-sufficiency requirement as well as investment capacity.
(4) Price and market related factors including output and input prices as well as trade policies and other economic policies that affect these prices either directly or indirectly.
(5) Institutional and infrastructure related factors covering farm size and tenancy arrangements, research, extension and marketing systems and government regulatory policies.

1.5 Definition of Agricultural Intensification
Agricultural intensification can be technically defined as an increase in agricultural production per unit of inputs (which may be labour, land, time, fertilizer, seed, feed or cash). For practical purposes, intensification occurs when there is an increase in the total volume of agricultural production that results from a higher productivity of inputs, or agricultural production is maintained while certain inputs are decreased (such as by more effective delivery of smaller amounts of fertilizer, better targeting of plant or animal protection, and mixed or relay cropping on smaller fields).

1.6 Major types of crop intensification
Agricultural Intensification occur majorly in two form
(1) Agricultural Intensification when there is a need to expand the food supply, for example during periods of rapid population growth.
(2) Agricultural Intensification that makes more efficient use of inputs may be more critical when environmental problems or social issues are involved.

2. Literature Review
Many studies are conducted on diversification and intensification of cropping system, for the purpose of present study we have divided the literature in two major parts that is Effect of diversification and intensification on Growth and yield parameter and on Economics and Energeics and Effect of land configurations on growth and yield.

2.1 Effect of diversification and intensification on following heads
a) Growth and yield parameter
b) Economics and Energetics

2.2 Effect of land configurations on growth and yield
2.2.1 Effect of diversification and intensification
i) Growth and yield parameter
Maurya and Rathi (2000) [53] found that total dry matter, straw and grain yield of wheat were greatest after the additive series of Soybean + Pigeonpea, followed by the replacement series which was at par with sole soybean.
Gulzar *et al.* (2001) [26] reported that intercropping significantly reduced plant height of soybean and taller plants were observed in sole cropping system. Days to maturity of soybean increased in intercropping compared to mono cropping. There was no significant effect on the height and days to maturity of maize in intercropping and mono cropping systems.
Stoopa *et al.* (2001) reviewed a system of rice intensification (SRI) from Madagascar, they have studied the plant physiological and bio-ecological factors associated with agronomic practices. Their study showed that increased yields of rice in Madagascar are achieved through more productive use of the natural resources (land, water, seeds and plant nutrients) and of labor, time and space. The intensification approach like SRI will be important for small farmers from diverse and location-specific production systems who need to achieve both higher yields and increased net profits. Other major implication of SRI and intensification is that if we do some simple but profound adjustments in agronomic management practices, we can untapped production potentials of rice and other major cereal grain crops, without any extra costs to farmers or to the environment.
Raghuwanshi *et al.* (2002) [73] conducted an experiment at Indore, Madhya Pradesh and concluded that the intercropping systems, soybean and sorghum at 1:2 ratio resulted in the highest soybean equivalent yield (1982 kgha^{-1}).
Khan *et al.* (2005) [40] investigated the feasibility of intercropping of chickpea, lentil and rapeseed in wheat under rainfed condition. The results showed that plant height, spike length, number of grains per spike and grain yield of wheat varied significantly among intercropping systems, while the effect on 1000-grain weight was non-significant in all cases. Plant height, spike length, number of grains per spike and grain yield of wheat was higher with chickpea intercropping.

The mean values of different proportions showed that the highest grain yield of wheat (1687 kg ha^{-1}) was obtained with chickpea intercropping. Among different ratios of intercropping systems, the chickpea intercropping in 1:1 ratio gave the highest grain yield (1721 kg ha^{-1}) of wheat.

Gill *et al.* (2009) [23] studied the effect of mixed cropping of wheat and chickpea on their growth and nodulation in chickpea. When grown in mixture, wheat had an inhibitory effect on root proliferation, total biomass and grain yield of chickpea. The value of different parameters in mixture being one third of that determined when chickpea was grown as a sole crop. Contrary to chickpea, biomass yield of wheat increased by >100% due to the companion crop. The improvement was observed in all the plant components except for 100-grain weight that showed a significant decrease; harvest index and green-ness of flag leaf was not affected.

Caviglia *et al.* (2011) [13] assessed the yield and quality of wheat and soybean in relay and sequential double-crops as compared with control sole crop in Argentina. The results indicated that in comparison to sole-crops, double-cropping increased grain yield and glucose equivalent yield by 58 to 82% and harvest index by 91 to 143%.

Undie *et al.* (2012) [91] investigated yield and productivity of maize and soybean as sole crops and as additive mixtures (100:100) at Akamkpa, Nigeria. It revealed that intercrops were 64, 66 and 63 percent in 2007 and 43, 57 and 65 percent in 2008, more productive than the sole crops at 2:2, 1:2 and 1:1 arrangements, respectively. Late season maize and soybean may be planted in 2:2 or 1:2 arrangements to take advantage of optimum soybean seed yield and 65-100 percent of the maize grain yield in the humid Southern Nigeria.

Bommarco *et al*. (2012) [11] review ecological intensification, there review highlight the importance of ecological intensification as environmentally friendly replacement of anthropogenic inputs for enhancement of crop productivity. Further they suggest for an effective ecological intensification we requires to understand the relations between land use at different scales and the community composition of ecosystem service. They also find critical gap in this area and emphasize on need of more multidisciplinary research approaches to address critical knowledge gaps in ecological intensification.

Ijoyah *et al.* (2013) [34] conducted an experiment atthe Research Farm, University of Agriculture, Makurdi, Nigeria to evaluate the effect of soybean-maize intercropping on yield and system productivity. Results of study showed that intercropping soybean and maize gave land equivalent ratio (LER) values of 1.40 and 1.29, respectively indicating that higher productivity per unit area was achieved by growing the two crops together than by growing them separately.

Mahmoudi *et al.* (2013) [48] studied the effects of strip intercropping on grain yield of maize and soybean. Strip intercropping planting patterns included: 2 maize+2 soybean rows (2:2), 2 maize+4 soybean rows (2:4), 2 maize+ 6 soybean rows (2:6), 3 maize+4 soybean rows (3:4), 3 maize+6 soybean rows (3:6), 4 maize+4 soybean rows (4:4), 4 maize+6 soybean rows (4:6) and sole cropping of maize and soybean. Results indicated that maximum seed yields of soybean (2261 kg ha^{-1}) and maize (10390 kg ha^{-1}) were obtained in planting patterns of 2:6 and 3:4, respectively. The results showed that the intercropping treatments have significant effects on maize grain yield, mean number ear per plant, number of seed per ear and weight of maize. Furthermore, intercropping treatments showed significant effects on grain yield, mean No. of pods per plant, No. of seeds per pod and seed weight of soybean.

Yogesh *et al.* (2014) [102] conducted afield experiment at University of Agricultural Sciences, Dharwad (Karnataka) and found that, among crop and cropping systems, maize intercropped with soybean in 2:6 paired row (45/180 cm) recorded the least land equivalent ratio (LER) and the highest light absorption. Sole maize recorded significantly higher yield (70.92 q ha^{-1}) than intercropped maize under varying geometry and row proportion. However, it was at par with maize intercropped with soybean in 1:1 row proportion 60x20 cm (70.03 q ha^{-1}). The yield of sole soybean was significantly superior (21.80 q ha^{-1}) over other intercropped treatments. Highest net return (Rs 57,926 ha^{-1}) and B:C ratio (3.57) were obtained with maize intercropped with soybean in 2:6 paired row. Similarly, higher LER (1.54), Area time equivalent ratio (ATER) (1.32) and maize equivalent yield (94.70 q ha^{-1}) were also noticed with Maize+Soybean intercropping in 2:6 paired row than other treatments.

Naresh *et al.* (2014) [60] conducted a field experiment at Meerut, (U.P.) to evaluate that intercropping can increase light interception, shading and reduce evaporation rate as compared to sole maize. The grain yield and yield attributing characters of wheat crop increased significantly under intercropping treatments when compared with wheat only. Wheat yield significantly increased up to 160 kg N ha^{-1}. However, there was no significant increase in yield of maize beyond 120 kg N ha^{-1}. Sole maize-wheat rotation showed a decline in soil organic carbon by 3.7%, while black gram and cowpea intercropping with maize in paired rows (2:2 rowratio) followed by wheat had increased contents of per cent organic carbon in soil as 0.63 and 0.67, respectively as compared to initial values of 0.54%.

Tawfiq and Ahmad (2014) [86] revealed that intercropping systems significantly affected the wheat yield attributing characters, biological yield, grain yield, harvest index, LER, flag leaf area, chlorophyll and protein content. It was found that the cropping system of 1wheat: 2 legumes (Pea and chickpea) were more effective on yield attributing characters of wheat compared to other systems, whereas the systems of sole wheat and broadcast exhibited the lowest effect on most characters.

Mobasser *et al.* (2014) [55] reported that intercropping of cereal with legume crops helped to maintain and improve soil fertility, because crops such as cowpea, mung bean, soybean and groundnut accumulated from 80 to 350 kg nitrogen ha^{-1}. The main advantage of intercropping is the more efficient utilization of the available natural resources and the increased productivity compared with each sole crop of the mixture.

Shirvanian *et al*. (2014) [79] investigated the effect of planting date and seed mixing ratio on dry matter distribution in maize and soybean. The results showed that the effect of different levels of intercropping ratio on dry weight of the plant organs and total dry matter was not significant, but the intercropping ratio of 25% maize and 75% soybean was determined as the superior intercropping ratio. In this ratio, the maize allocated the highest total dry weight (14.37 t ha^{-1}) and the highest leaf dry weight (3.51 t ha^{-1}) and corn ear dry weight (6.97 g) to itself in intercropping.

Mandal *et al.* (2014) [51] found that the grain yield and stover yield of maize were significantly higher in case of pure stand of maize than either of its intercropping systems with legumes while the crop yield was highest in the maize with soybean (1:2) intercropping system and it was statistically at par with the yield obtained in sole maize. The grain yield of legume was highest in maize with groundnut intercropping (1:2) and it had highest yield followed by solegroundnut. The maize equivalent yield was highest in maize with soybean intercropping (1:2) followed by maizewith groundnut (1:2), maize with groundnut (2:4) and maize with soybean (2:4) intercropping.

Zhang. *Et al.* (2015) [103] determine that for enhancing food supply without using extra nutrients could be possible by maximizing the efficacy of intercropping as a means of delivering more crop production per unit of fertilizer applied. Their study provide new insights into root/rhizosphere interactions with maize/faba bean intercropping in the systems as an example with variable supply of P, there study is important in developing strategies for rhizosphere management through optimizing plant combinations and soil nutrient supply to increase crop productivity and nutrient-use efficiency.

Newaj *et al*. (2016) [61] in their research founded that Agroforestry enhance the uptake of CO2 it also reduce its emission and has the potential to remove a significant amount of CO2 from the atmosphere, further they suggest Agroforestry options may provide a means for diversifying production systems and increasing the sustainability of smallholder farming systems. Thus, diversifying the production system to include a significant tree component may buffer against climatic variability.

ii) Economics and energetics

Chaudhary and Safeer (2000) [15] recorded higher grain yields of wheat and soybean in relayed pattern as compared with those of sole wheat and soybean. There was an increase of Rs 6370 and Rs 3840 in net income of relayed cropping as compared to sole wheat and sole soybean, respectively. The benefit cost ratio of wheat soybean relay cropping system was higher as compared to sole wheat and soybean.

Thakur *et al.* (2000) [88] determined the productivity and economics of gram (*Cicer arietinum*)-based intercropping systems in Madhya Pradesh. Safflower and linseed were suitable substitutes for gram in terms of gram equivalent yield, monetary advantages and benefit: cost ratio. Gram + Safflower intercropping at 3:1 and 6:2 rows 30 cm apart proved more advantageous than pure stands of either crop components and other intercropping systems in terms of gram equivalent yield, land equivalent ratio (LER), monetary returns and benefit: cost ratio.

Mandal *et al.* (2002) [49] studied the energy requirement and energy input–output relationship of soybean-based crop production systems viz., Soybean (*Glycine max* (L.) Merr.)-Wheat (*Triticum aestivum* L.), Soybean–Mustard (*Brassica juncea* (L.) Czern & Coss) and Soybean–Chickpea (*Cicer arietinum* L.) in central India. The total bioenergy output of the crop production systems followed the order: Soybean–Wheat (131277±29.26 MJ ha^{-1}) > Soybean–Mustard (101661±28.91 MJ ha^{-1}) > Soybean–Chickpea (92658±28.87 MJ ha^{-1}).But this order was reversed for energy-use efficiency (EUE). Soybean is the most energy-investment intensive crop. Energy intensiveness (MJ Rs^{-1}) was higher in wheat (1.40) followed by mustard (1.11), soybean (0.89) and chickpea (0.87) and the Soybean–Wheat system (1.13) emerged as the most energy-intensive system compared to Soybean–Mustard (0.97) and Soybean–Chickpea (0.88).

Saeed and Imran (2002) [76] studied on wheat-Gram intercropping system under different size of wheat strips in Pakistan. It was carried out to determine the agro-economic relationship of two important crops of Pakistan. The highest net income of Rs 10229 ha^{-1} with benefit-cost ratio of 1.90 was obtained from wheat grown in 100 cm spaced 4-row strips + 3 rows of gram while minimum net return was of Rs 6679 ha^{-1} from 10-row strips + 3 rows of gram.

Rasul and Thapa (2003) [75] examine the sustainability of conventional and ecological agricultural on different parameters like their environmental soundness, economic viability and social acceptability. Their finding reveals that ecological agriculture could become an alternative to conventional agriculture if market distortions created by subsidies were removed, and financial benefits were provided to resource-conserving farmers along with necessary support through extension, credit, research, and marketing.

Yadav *et al.* (2005) [100] conducted an experiment in Uttar Pradesh to evaluated the performance of different cropping sequences viz., Rice-Wheat-Sesbania (C_1), Rice-Mustard-Sunflower (C_2), Rice-Mustard-Green gram (C_3), Rice-Maize-Sesbania (C_4), Maize-Potato-Sunflower (C_5), Maize-Potato-Wheat (C_6), Maize-Vegetable-Sunflower (C_7), Soybean-Wheat (C_8) and Rice-Wheat (C_9). During the rainy season, C_1 and C_7 recorded the highest grain and straw yield, respectively. During the winter and summer, C5 recorded the highest grain yield. Rice equivalent yield, total calories and land use efficiency were highest in C_6, C_5 and C_1, respectively. Net returns and production efficiency were highest in C_7.

Hile *et al.* (2007) [32] studied the intensification and diversification in Maize-Wheat, Maize-Groundnut, Maize-Onion and Maize-Chilli cropping sequences. The Maize-Chilli cropping system was found significantly superior, recording the highest maize equivalent yield, net monetary returns and benefit: cost ratio followed by the Maize-Onion, Maize-Wheat and Maize-Groundnut cropping systems.

Thakur *et al.* (2009) [89] revealed that the existing Rice-Wheat cropping system should be diversified to short duration Rice (IET-1410)-Cauliflower-French bean which recorded highest rice equivalent yield (REY) of 27.20 t ha^{-1} $year^{-1}$, net return of Rs. 105085 ha $year^{-1}$ and production efficiency of 74.52 kg $ha^{-1}day^{-1}$. The REY of short duration Rice (IET-1410)–Potato-Wheat, medium duration Rice (PC-19) - Potato-Rajmash and basmati Rice (Basmati370)-Potato-Okra were next in order. Maximum energy of 77.70 x 106K calories $ha^{-1}year^{-1}$ was produced in medium duration Rice (PC-19)-Pea-Maize (cob's), followed by short duration Rice (IET-1410)-Potato-Wheat and medium duration Rice (PC-19)-Potato-Rajmash.

Walia *et al.* (2010) [94] revealed that Rice-Wheat cropping system proved the most effective in producing highest calorific value of 40915 K calories $ha^{-1}annum^{-1}$ followed by Maize-Wheat-Summer Moongbean (39517 K calories ha^{-1} $annum^{-1}$).

Kumar *et al.* (2012) [44] found that hybrid Rice-Potato-Green gram sequence was found most efficient with respect to system profitability (391.6 Rs. ha^{-1} $year^{-1}$), monetary returns (Rs. 125 x 103 $ha^{-1}year^{-1}$) and energy production (54.2 x 106 kcal.). Intensification through inclusion of oilseeds and pulses crops increased the energy output and nutrient use efficiency.

Prasad *et al.* (2013) conducted a field experiment at Kanke, Ranchi to evaluate the production potential, resource use efficiency of rice based cropping systems. It was found that the maximum net profit (125 x 103 Rs ha^{-1}), benefit cost ratio (1.61) and monetary effficency (342.7 Rs $ha^{-1}day^{-1}$) recorded in Rice-Potato-Greengram sequence which were significantly superior over other cropping systems.

Teklewold *et al*. (2013) [87] has studied Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia according to them sustainable agricultural practices (SAPs) have a significant effect on agricultural productivity and food security there result shows that adoption of SAPs increases maize income and the highest payoff is achieved when SAPs are adopted in combination rather than in isolation. Use of nitrogen fertilizer is lower when system diversification and conservation tillage is used in combination. But conservation tillage increased pesticide application and labor demand, perhaps to compensate for reduced tillage, although when conservation tillage is jointly used with system diversification, it does not have a significant impact on pesticide and labor use, lastly this adoption of SAPs package has increased women workload.

Singh and Kumar (2014) [60] conducted a field experiment at Dehradun, Uttarakhand. The result revealed that the Rice-Potato-Greengram cropping system recorded highest net returns (Rs 1,61,928 ha^{-1}) followed by Rice-Vegetable Pea-Vegetable French bean (Rs 1,58,192 ha^{-1}) and Rice-Potato-Vegetable Cowpea cropping systems (Rs 1,52,415 ha^{-1}). The highest benefit cost ratio (1.93) was recorded with the Rice-Vegetable Pea-Vegetable Frenchbean cropping system owing to its lower cost of cultivation and higher returns.

iii) Effect of land configurations on growth and yield

Singh (2000) study environmental consequences of agricultural development in Haryana, India his finding reveals that Haryana state has made much progress in agricultural productivity, but at the cost of land and water degradation. Intensive agriculture during the Green Revolution has brought significant land and water problems relating to soil degradation over exploitation of ground water and soil pollution due to the uses of high doses of fertilizers and pesticides. He further suggest that conservation of these resources is essential for sustainable agricultural. There is a need of integrated and sustainable monitoring and management of agriculture and forestry. Effective utilization of land and water, inventory data for land use planning, nutrient management, increased biomass productivity and need for diversification, re-enrichment of inherent fertility should be a priority of policy maker and farmer.

Tumbare and Bhoite (2000) [90] conducted an experiment at the Khospuri watershed, Maharashtra in India and revealed that maximum yield of bajra was observed under broad bed furrow (BBF) and ridges and furrow methods. During *rabi* season also significantly higher yield of gram was obtained under BBF and ridges and furrow compared to flat sowing, border strips, and compartment sowing method.

Khatri *et al*. (2002) [41] reported that growth parameters such as number of tillers per meter row length, leaf area index, crop growth rate and dry matter accumulation, as well as yield attributes such as number of grains per earhead, grain yield per earhead and test weight were higher with sowing in raised beds as compared to flat beds in wheat.

Nagavallemma *et al.* (2005) [59] conducted an experiment at the ICRISAT, Hyderabad to evaluate the effect of landform and soil depth on the performance of soybean-based cropping systems. Soybean followed by chickpea grown on broad bed furrow (BBF) landform on medium-deep soil produced maximum yield as compared to flat land form on medium-deep soils.

Kantwa *et al*. (2006) implemented a field experiment in New Delhi, India and reported that broad bed and furrow system of planting recorded higher biomass and grain yield of pigeon pea (*Cajanus cajan*), pigeon pea equivalent yield, N and P uptake, net returns over flat bed planting.

Pal and Biswas (2008) [65] conducted an experiment in West Bengal, India which revealed that ridge-bed method of planting of maize had significant influence on plant height, basal girth, dry matter accumulation, crop growth rate and root length. Twenty-five days old seedlings when planted on ridge method recorded the highest growth characters.

Patel *et al*. (2009) [68] studied the effect of irrigation and land configuration on growth, yield and quality of chickpea under Vertisol of South Gujarat (Navsari). Results revealed that irrigating the crop at 0.8 IW/CPE ratio with ridges and furrow method of sowing gave significantly higher seed and straw yield with better quality of chickpea.

Rajput *et al.* (2009) [74] implemented the community-based field operational research project in the Vertisols of Madhya Pradesh and evaluated that the raised-sunken bed system (RSBS) of land treatment was used to enhance in situ rainwater conservation and minimize soil erosion and nutrient losses. Grain yields of wheat (*Triticumaestivum*) and chickpeas (*Cicer arietinum*) were higher in this system than in the flatbed system (FBS) of planting. Soybean (*Glycine max*) yield increased nearly 100% with the ridge-furrow system (RFS) and about 55% in broad-bed and furrow system (BBFS) compared with the FBS.

Paliwal *et al.* (2011) [66] found that ridge and furrow planting of soybean significantly increased yield attributes, yields and net return over normal sowing, while the yield and yield attributes and net return were recorded higher with broad bed furrow planting in wheat.

Jadhav *et al*. (2012) [36] studied the effect of mechanization with different land configuration on growth and growth attributes of soybean. The result showed that, yield contributing character viz., number of pods $plant^{-1}$, seed yield weight (g) $plant^{-1}$, 100 seed weight (g), seed yield (q ha^{-1}), straw yield (q ha^{-1}) and harvest index (%) also found higher in broad bed furrow followed by ridges and furrow. Treatment of broad bed furrow with mechanized culture also improved significantly soil moisture content, consumptive use, relative water use and absolute water use.

Lakpale *et al.* (2012) [45] implemented an experiment at Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur and revealed that growth parameters, yield attributes and seed yield of soybean were the highest under ridge and furrow sowing. Seed yield of soybean was unaffected due to different seed rates. The economic returns were maximum under ridge and furrow planting. Alternatively, broad-bed planting with 4 rows with seed yield of (2,214 kg ha^{-1}) offering net returns of Rs 33,520 with B:C ratio of 3.50 should be the preferred method over other methods.

Mandal *et al.* (2013) [50] conducted field experiments at the Research farm at Bhopal to evaluate the land surface configuration and crop diversification. Results of experiment on Vertisols showed a considerable reduction in run off of water and also soil loss from broadbed and furrow (BBF) compared to flat-on-grade (FOG) during rainy season and at the same time crop productivity was significantly improved in BBF. It enhanced yield of soybean (*Glycine max* (L.) Merr.), maize (*Zeamays* L.), pigeonpea (*Cajanus cajan* (L.) Millsp.) As sole and as well as intercropping and sole chickpea (*Cicer arietinum* L.) by about 12.7-20.0% over FOG. The yield of various crops (Soybean, maize and pigeonpea), expressed as soybean equivalent yield, was compared and it showed an improvement in yield from different intercropping systems on BBF. Water use efficiency (WUE) of chickpea was more under BBF than FOG.

3. Research gaps identified in the proposed field of investigation

A thorough and extensive review of literature reveals that although there is lot of empirical work done on the issue like Landrya. *Et al* (2016) [46], Zhang. *Et al* (2015) [103], Bajracharya. *Et al*. (2015) [8] world over but these studied are very recent, but very few empirical work is found out in India like Nagavallemma *et al*. (2005) [59], Shri *et al*. (2014) [83] and Paliwal *et al*. (2011) [66] to name a few. Ijoyah *et al*. (2013) [34] and Teklewold *et al*. (2013) [87] Significant work is done in emerging economy like is Africa. We proposed an empirical analysis and field experiment in cropping system in India. The researches done in India is confined to a single season there is a lack of long term experiment taking two of three cropping system in India. The major research was focused on rice and wheat other cash crop like soyabean, maize and gram are needed to be analyzed especially in Madhya Pradesh. The review research like Stoopa *et al*. (2001) reviewed a system of rice intensification (SRI) found significant gap in applying their study to other part of the world. Similarly Zhang. *Et al*. (2015) [103] and Landrya. *Et al*. (2016) [46] found a significant gap in acceptability and viability of their study in other geographical borders. Bommarco *et al*. (2012) [11] review ecological intensification and has find critical gap in this area and emphasize on need of more multidisciplinary research approaches to address critical knowledge gaps in ecological intensification.

4. Conclusion and Suggestion

The previous researcher proof that crop diversification and intensification are proven methods to fight climatic change. The topic lacks some of the empirical work, so the authors suggest some empirical work on issue. Some more studied are needed to be conducted in emerging economy like Africa and southern Asia. In country like India where climatic condition are very diverse and the sight change in climate can affect the overall cropping system of the region, it is suggested that the policy maker and industry should consider crop diversification and intensification to fight climate change also these method will be very important for small and marginal farmer who depends on small land and one crop for their living.

5. Reference

1. Adaniyan ON, Akande SR, Balogun MO, Saka JO. Evaluation of Crop Yield of African Yam Bean, Maize and Kenafunder Intercropping Systems. American-Eurasian J Agric. Environ. Sci. 2007; 2(1):99-102.
2. Akhtar M, Yaqub M, Iqbal Z, Ashraf MY, Akhter J, Hussain F. Improvement in yield and nutrient uptake by co-cropping of wheat and chickpea. Pak. J Bot. 2010; 42(6):4043-4049.
3. Alhassan GA, Kalu BA, Egbe OM. Influence of Planting Densities on the Performance of Intercropped Bamabra Groundnut with Cowpea in Makurdi, Benue State, Nigeria. Intn. J Develop. Sustain. 2012; 1(3):1-20.
4. Alom MS, Paul NK, Quayyum MA. Production potential of different varieties of hybrid maize Zea mays L. with groundnut Arachis hypogaea L. under intercropping system. Bangladesh J Agric. Res. 2010; 35(1): 51-64.
5. Anonymous. State of Indian Agriculture. Govt. of India, Ministry of Agriculture, Department of Agriculture and Cooperation, New Delhi, 2013.
6. Anonymous. Directorate of economics and statistics, Department of Agriculture and Cooperation, fourth advance estimates, New delhi, 2014.
7. Ariel CE, Eduardo OA, Benito GE, Lidia G. Effects of two plant arrangements in corn Zea mays L. and soybean Glycine max L. Merrill intercropping on soil nitrogen and phosphorus status and growth of component crops at an Argentinean Argiudoll. Am. J Agric. and Forestry. 2013; 1(2):22-31.
8. Bajracharya RM, Atreya K, Raut N, Shrestha HL, Gautam DK, Dahal NR. Sustainable diversified agriculture and land management in the himalaya: implications for climate change adaptation and mitigation Journal of Mountain Area Research, 2015; 01:40-52.
9. Baquerizo M, Reich P, Palacios P, Milla R. Biogeographic bases for a shift in crop C: N: P stoichiometries during domestication. Ecology Letters, 2016; 1-12.
10. Bezuidenhout SR, Laing M. Allelopathy and its influence in soil systems. In: Biological approaches to sustainable soil systems. Eds.: N. Uphoff *et al*., Taylor and Francis Group, NY, 2006; 231-240.
11. Bommarco R, Kleijn D, Potts S. Ecological intensification: harnessing ecosystem services for food security Trends in Ecology and Evolution, 2012; 20:1-9.
12. Butterly C, Armstrong R, Chen D, Tang C. Free-air CO2 enrichment FACE reduces the inhibitory effect of soil nitrate on N2 fixation of Pisum sativum Annals of Botany, 2015, 1-9.

13. Caviglia OP, Sadras VO, Andrade FH. Yield and quality of wheat and soybean in sole- and double-cropping. Agron. J. 2011; 103(4):1081-1089.
14. Ch. Pallavi B, Joseph Khan MA, Hemalatha S. Economic Evaluation of Finger Millet under different Nutrient Management Practices. International Journal of Current Microbiology and Applied Sciences. 2016; 5(8):690-698.
15. Chaudhary MA, Safeer M. Effect of wheat- soybean relay cropping on soil moisture content and crop yield under rainfed condition. Pak. J Soil Sci. 2000; 18(1-4):51-54.
16. Dazhong W, Pimentel D. Energy flow through an organic agroecosystems in China. Agriculture, Ecosystems and Environmental, 1984; 11:145-160.
17. Devaranavadgi VS, Bosu SS. Effect of insitu moisture conservation practices in deep clay soils on growth and yield of maize Zea mays L. under rainfed condition. Karnataka J. Agric. Sci. 2014; 27(4):507-510.
18. Donald CM, Hamblin J. The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Adv. Agron. 1976; 28:361-405.
19. Egbe OM. Effects of plant density of intercropped soybean with tall sorghum on competitive ability of soybean and economic yield at Otobi, Benue State, Nigeria. J. Cereals and Oilseeds. 2011; 1(1):1-10.
20. Erkossa T, Stahr K, Gaiser T. Soil tillage and crop productivity on a Vertisol in Ethiopian highlands.Soil & Tillage Res. 2005; 85:200-211.
21. Ghosh PK, Manna MC, Bandyopadhyay KK, Ajay Tripathi AK, Wanjari RH, Hati KM, Misra AK, Acharya Subba Rao CL. Interspecific interaction and nutrient use in soybean/sorghum intercropping system. Agron. J, 2006; 98:1097-1108.
22. Ghosh PK, Mohanty M, Bandyopadhyay KK, Painuli DK, Misra AK. Growth, competition, yield advantage and economics in soybean/pigeonpea intercropping system in semi-arid tropics of IndiaI. Effect of subsoiling.Field Crops Res, 2006; 96:80-89.
23. Gill S, Abid M, Azam F. Mixed cropping effects on growth of wheat Triticum aestivum l. and chickpea (Cicer arietenum l. Pak. J Bot. 2009; 41(3):1029-1036.
24. Gill SM, Abid M, Azam F. Root-induced changes in potential nitrification and nitrate reductase activity of the rhizospheric soil of wheat Triticum aestivum L and chickpea Cicerarietinum L. Pak. J Bot. 2006; 38:991-997.
25. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research, John Willey and Sons, New York, 1984.
26. Gulzar Ahamad, Zar Quresh, Khan SD, Aqib Iqbal. Study on the intercropping of soybean with maize. Sarhad J Agric. 2001; 17(2):235-238.
27. Gupta PK. Soil, Plant, Water and Fertilizer analysis. Agrobios India, Jodhpur, 2009, 223-224.
28. Hari Ram, Kler DS. Growth analysis of soybean Glycine max L. Merrill. and wheat Triticum aestivum L. emend. Fiori and Paol in sequence under no tillage and permanentraised bed planting. Indian J Ecol. 2007; 34:154-57.
29. Hari ram, Singh G, Aggarwal N, Kaur J. Soybean Glycine max growth, productivity and water use under different sowing methods and seeding rates in Punjab. Indian J Agron. 2011; 56(4):377-380.
30. Hazra CR. Expert consultation on crop diversification in the Asia–Pacific region. FAO Country Report, India. FAO Corporate Documents Repository. E-book Available: http://www.fao.org, 2000.
31. Hiebsch C, Tetio-Kagho F, Chirembo FP. Plant density and soybean maturity in a soybean-maize intercrop. Agron. J. 1995; 87:965-970.
32. Hile RB, Patil YJ, Patil HM. Economics of intensification and diversification of the exiting cropping system in plain zone area of Nasik, India. Intn. J Agric. Sci. 2007; 3(2):224-226.
33. Hoggaard-Nielsen H, Ambus P, Jensen ES. Interspecific competition, use and interference with weeds in pea-barley intercropping. Field Crops Res. 2001; 70:101-109.
34. Ijoyah MO, Ogar AO, Ojo GOS. Soybean-maize intercropping on yield and system productivity in Makurdi, Central Nigeria. Scientific J Crop Sci. 2013; 2(4):49-55.
35. Jackson ML. Soil Chemical Analysis, Prentice Hall of India Private Limited, New Delhi, 1973, 187.
36. Jadhav JA, Patil DB, Ingole PG. Effect of mechanization with different land configuration on yield and in situmoisture conservation of soybean. Intn. J. Agric. Sci. 2012; 8(1):48-51.
37. Joshi PK, Ashok G, Birthal PS, Laxmi T. Nature and Speed of Agricultural Diversification in South Asian Countries. Paper Presented at the ICRIER ICAR IFPRI Conference on Economic Reforms and Food Security. The Role of Trade and Technology, New Delhi, India, 2002.
38. Kantawa SR, Ahlawat IPS, Gangaiah B. Performance of sole and intercropped pigeonpea Cajanus cajan as influenced by land configurations, post-monsoon irrigation and phosphorus fertilization. Indian J. Agric. Sci. 2006; 76(10):635-637.
39. Karimi MI, Beheshti Tabar M, Khubbakht GM. Energy Production in Iran’s Agronomy. American-Eurasian J. Agric. & Environ. Sci. 2008; 4(2):172-177.
40. Khan M, Khan RU, Wahab A, Rashid A. Yield and yield components of wheat as influenced by intercropping of chickpea, lentil and rapeseed in different proportions. Pak. J Agri. Sci. 2005; 42:3-4.
41. Khatri RS, Goel AC, Malik RK. Comparative wheat crop performance in bed sowing and conventional flat sowing in rice - wheat system under different irrigation level. Haryana Agril. Univ. J Res. 2002; 32(1):11-18.
42. Kiani S, Houshyar E. Energy Consumption of Rainfed Wheat Production in Conventional and conservation tillage Systems. Intn. J Agric. and Crop Sci. 2012; 4(5):213-219.
43. Krupinsky JM, Bailey KL, McMullen MP, Gossen BD, Turkington TK. Managing plant disease risk in diversified cropping systems. Agron. J, 2002; 94:198-209.
44. Kumar A, Tripathi HP, Yadav RA. Intensification and diversification in rice Oryzasativa - wheat Triticun aestivum cropping system for sustainability. Indian J Agron. 2012; 57(4):319-322.
45. Lakpale R, Tripathi VK. Broad-bed furrow and ridge and furrow method of sowing under different seed rates of

soybean Glycine max L. for high rainfall areas of Chhattisgarh plains. Soybean Res. 2012; 10:52-59.
46. Landrya G, Scow K, Brennan E, Torbert E, Vitousek P. Higher flexibility in input N:P ratios results in more balanced phosphorus budgets in two long-term experimental agro ecosystems. Agriculture, Ecosystems and Environment, 2016; 223:197-210.
47. Li L, Sun JH, Zhang F, Li XL, Yang SC, Rengel Z. Wheat/maize or wheat/soybean strip intercropping. I. Yield advantage and interspecific interactions on nutrients. Field CropsRes. 2001; 71:123-137.
48. Mahmoudi R, Jamshidi K, Pouryousef M. Evaluation of grain yield of maize Zea mays L. and soybean Glycine max L. in strip intercropping. Intn. J. Agron. Pl. Production. 2013; 4(9):2388-2392.
49. Mandal KG, Saha KP, Ghosh PK, Hati KM, Bandyopadhyay KK. Bioenergy and economic analysis of soybean-based crop production systems in central India. Biomass and Bioenergy. 2002; 23:337-345.
50. Mandal KG, Hati KM, Misra AK, Bandyopadhyay KK, Tripathi AK. Land surface modification and crop diversification for enhancing productivity of a Vertisol. Intn. J Pl. Production. 2013; 7(3):455-472. http:// www.ijpp.info
51. Mandal MK, Banerjee M, Banerjee H, Alipatra A, Malik GC. Productivity of maize Zea mays based intercropping system during kharif season under red and lateritic tract of west Bengal. An Intn. quarterly J life Sci. 2014; 9(1):31-35. http:// www.thebioscan.in.
52. Matusso JMM, Mugwe JN, Mucheru-Muna M. Effects of different maize Zea mays L. - soybean Glycine max L. Merrill intercropping patterns on soil mineral-N, N-uptake and soil properties. Afri. J Agric. Res. 2014; 9(1):42-55. http://www.academicjournals.org/AJAR
53. Maurya BM, Rathi KS. Growth and development of soybean as influenced by intercropping with pigeon pea and phosphorus level. Gujarat Agi. Univ. Res. J. 2000; 26(1):1-5.
54. Memon SQ, Mirza BB, Mari GR. Tillage practices and effect of sowing methods on growth and yield of maize crop. Agricultura Tropica Et Subtropica. 2007; 40(3):89-100.
55. Mobasser HR, Vazirimehr MA, Rigi K. Effect of intercropping on resources use, weed management and forage quality. International J Pl. Animal Environ. Sci. 2014; 4(2).
56. Muneer AP, Fida HM, Mumtaz AK, Muhammad IS. Performanceof maize in intercropping system with soybean under differentpatterns and nitrogen levels. J Appl. Sci. 2004; 4(2):201-205.
57. Munish K, Singh RA, Singh SP. Performance of moisture conservation practices and levels of nitrogen on sorghum under rainfed ecosystem of central Uttar Pradesh. Indian J Soil Conservation. 2008; 36:22-23.
58. Muoneke CO, Ogwuche MAO, Kalu BA. Effect of maize planting density on the performance of maize/soybean intercropping system in a Guinea Savannah agro-ecosystem. Afri. J Agric. Res. 2007; 2(12):667-677.
59. Nagavallemma KP, Wani SP, Reddy MS, Pathak P. Effect of landform and soil depth on productivity of soybean-based cropping systems and erosion losses in Vertic Inceptisols. Indian J Soil Conser. 2005; 33(2):132-136.
60. Naresh Tomar RK, Sahi SS, Singh UP, Purushottam Singh SP, Parvinder Kumar B. Sustainability of maize-wheat cropping system by different legume intercropping and nitrogen level treatments on light distribution, soil temperature and crop productivity. Afri. J Pl. Sci. 2014; 8(4):204-213.
61. Newaj R, Chaturvedi OP, Handa AK. Recent development in agro forestry research and its role in climate change adaptation and mitigation Indian Journal of Agro forestry. 2016; 18(1):1-9.
62. Njoku DN, Muoneke CO. Effect of cowpea planting density on growth, yield and productivity of component crops in cowpea/cassava intercropping system. Agro-Science J Tropic. Agric., Food, Envrion. Extn. 2008; 7(2):106-113.
63. Olsen SR, Cole CV, Watnabe PS, Dean LA. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Circ, 1954; 939.
64. Onuh MO, Ohazurike NC, Ijezie A. Effects of Mungbean / Melon/maize Intercrop on the Growth and Yield of Mungbean Vigna radiata L. Wilczek Cultivated in Owerri Rainforest Area. World J Agric. Sci. 2011; 7(2):161-165.
65. Pal AK, Biswas S.Growth of transplanted maize Zea mays L. as influenced by methods of planting and ages of seedlings. Crop Res. Hisar. 2008; 36(1/3):63-66.
66. Paliwal DK, Kushwaha HS, Thakur HS. Performance of soybean Glycine max-wheat Triticum aestivum cropping system under land configuration, mulching and nutrient management. Indian J Agron. 2011; 56(4):334-339.
67. Panda SC. Cropping and Farming Systems. Agribios India, Jodhpur, 2006, 8.
68. Patel KB, Tandel YN, Arvadia MK. Effect of irrigation and land configuration on growth, yield and quality of chickpea Cier arietinum L. under vertisol of South Gujarat. Intn. J Agric. Sci. 2009; 5(1):295-296.
69. Patiram, Brajendra NS, Thakur A, Ramesh T. Soil testing and analysis. New India publishing agency, Pitam Pura, New Delhi. 2007, 93-95.
70. Piper CS. Soil and plant analysis. Interscience Publishers. Inc. New York, 1950.
71. Prasad SN, Singh R. Productivity, economics an residual fertility under rainfed soybean based intercropping system in South Eastern Rajasthan. Indian J Soil Conser. 1997; 25(3):236-240.
72. Prasad D, Yadava MS, Singh CS. Diversification of rice Oryza sativa-based cropping systems for higher productivity, profitability and resource-use efficiency under irrigated ecosystem of Jharkhand. Indian J Agron. 2013; 58(3):264-270.
73. Raghuwanshi RK, Kushwaha SS, Gautam VS, Sharma NK. Chemical composition, nutrient uptake pattern, yield and economics in soybean – sorghum intercropping. Crop Res. 2002; 24:3(9):453-457.
74. Rajput RP, Kauraw DL, Bhatnagar RK, Bhavsar M, Velayutham M, Lal R. Sustainable management of Vertisols in Central India. J Crop Improvement. 2009; 23(2):119-135.

75. Rasul G, Thapa G. Sustainability Analysis of Ecological and Conventional Agricultural Systems in Bangladesh. World Development. 2003; 31(10):1721-1741.
76. Saeed MM, Imran M. Crop productivity and net returns in wheat-gram intercropping. Pak. J Agric. Res. 2002; 18(1):20-24.
77. Saleem R, Ahmed ZI, Ashraf M, Arif M, Malik MA, Munir M, Khan MA. Response of Maize-Legume Intercropping System to Different Fertlity Sources under Rainfed conditions. Sarhad J Agric. 2011; 27(4):503-511.
78. Sharma RP, Pathak SK, Haque M, Raman KR. Diversification of rice oryza sativa-based cropping systems for sustainable production in south bihar alluvial plains. Indian J Agron. 2004; 49(4):218-222.
79. Shirvanian M, Alavifazel M, Mojaddam M. The effect of planting date and seed intercropping ratio on dry matter distribution in maize intercropped with soybean. Indian J. Fundamental Applied Life Sci. ISSN: 2231-6345 Online Available at http://www.cibtech.org/jls.htm, 2014.
80. Singh DK, Kumar P. Influence of diversification of rice Oryza sativa - wheat Triticumaestivum system on productivity, energetics and profitability under on-farm conditions. Indian J Agron. 2014; 59(2):200-203.
81. Singh RB. Environmental consequences of agricultural development: a case study from the Green Revolution state of Haryana, India. Agriculture, Ecosystems and Environment, 2000; 82:97-103.
82. Solanki NS, Singh D, Sumeriya HK. Resources Utilization in Maize Zea mays-based Intercropping System under Rainfed Condition. Indian J Agric. Sci. 2011; 81(6):511-515.
83. Sonam shri, Jha AK, Shrivastava A. Evaluation of different intercropping systems for productivity and economics in maize Zea mays L. Ann. Agric. Res. New Series. 2014; 35(2):200-204.
84. Stoopa W, Uphoffb N, Kassamc A. A review of agricultural research issues raised by the system of rice intensification SRI from Madagascar: opportunities for improving farming systems for resource-poor farmers. Agricultural Systems, 2002; 71:249-274.
85. Subbiah BV, GL Asija. A rapid procedure for the determination of available nitrogen in soils. Current Science, 1956; 25:259-260.
86. Tawfiq SI, Ahmad KR. The Role of Intercropping Wheat with Legumes Chickpea or Pea in Improving the yield and Land Equivalent Ratio in Rain fed Regions. J Zankoy Sulaimani-Part A, Special Issue, 2014, 16.
87. Teklewold H, Kassie M, Shiferaw B, Köhlin G. Cropping system diversification, conservation tillage and modern seed adoption in Ethiopia: Impacts on household income, agrochemical use and demand for labor. Ecological Economics, 2013; 93:85-93.
88. Thakur NS, Pannase SK, Sharma RS. Production potential of gram Cicer arietinum-based intercropping systems under rainfed condition. Indian J Agron. 2000; 45(3):534-539.
89. Thakur NP, Kachroo D, Kumar J, Kour M, Kumar P. Diversification of rice-wheat cropping system in sub-humid Indo-Gangetic plains of Jammu. ORYZA- An Intn J Rice. 2009; 46(2):108-112.
90. Tumbare AD, Bhoite SU. Effect of moisture conservation techniques on growth and yield of pearl millet-gram sequence in watershed. Indian J Dryland Agric. Res. and Devel. 2000; 15(2):94-95.
91. Undie UL, Uwah DF, Attoe EE. Effect of Intercropping and Crop Arrangement on Yield and Productivity of Late Season Maize/soybean Mixtures in the Humid Environment of South Southern Nigeria. J Agric. Sci. 2012; 4(4):37. http:// www.ccsenet.org/jas
92. Verma *et al*. Manual on Soil Testing Methods. JN Krishi Vishwa vidhyalaya college of Agirculture, Indore. India, 2007.
93. Verma V. Textbook of Plant Physiology Ane's Publication II Edition. New Delhi. Indore, 2011.
94. Walia SS, Gill MS, Dhaliwal SS. Production potential and economics of different croppping systems and their impact on soil health. Indian j Ecol. 2010; 37(1):23-26.
95. Walkley A, Black IA. An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci., 1934; 37:29-37.
96. Watson DJ. The physiological basis of variation in yield. Adv. Agron. 1952; 4:101-105.
97. www.climatetechwiki.org. Crop Diversification and new varieties retrieved from http://www.climatetechwiki.org/content/crop-diversification-and-new-varieties. 2013-2016.
98. www.fao.org. Agriculture Intensification retrieved from http://www.fao.org/docrep/007/j0902e/j0902e03.htm. 2013-2016.
99. www.pininterest.com. Nutrient deficiency retrieved from https://www.pinterest.com/pin/97179304434945829/ last accessed 2013-2016.
100. Yadav MP, Raj J, Kushwaha SP, Singh GK. Production potential and economic analysis of various cropping systems for Central Plains Zone of Uttar Pradesh. IndianJ. Agron. 2005; 50(2):83-85.
101. Yang WM. Method of Farm Management, Investigation for Improving Farm Productivity. FAO - Agricultural Development, 1956; 64:228.
102. Yogesh S, Halikatti SI, Hiremath SM, Potdar MP, Harlapur SI, Venkatesh H. Light use efficiency, productivity and profitability of maize and soybean intercropping as influenced by planting geometry and row proportion. Karnataka J Agric. Sci. 2014; 27(1):1-4.
103. Zhang D, Zhang C, Tang X, Li , Zhang F, Rengel Z, *et al*. Increased soil phosphorus availability induced by faba bean root exudation stimulates root growth and phosphorus uptake in neighboring maize New Phytologist. 2015; 01:1-10.