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A REVIEW :

Macro-level transition and agricultural sustainability in Kashmir

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SUMMARY : Farming a key factor for the economic prosperity of any nation in the developing world. Over the years, farmers are welcoming any new technological systems to get crop yield. Farming sector is getting new challenges from biotic and abiotic factors. Advanced techniques and systems are getting popularity because of their important benefits for the poor farming community. The aim of present paper is to highlights the benefits of transition in the agriculture ecosystems in Kashmir Valley. This paper provides a retrospective account of the macro-level transitions in the agricultural sector and sub-sectors in Kashmir Valley. The paper examine distinct research traditions that continue to document farm transformation, macro-level transformation etc. The paper portrays the transformation of agricultural sub-sectors to the high value cash crops. The results reveal that a strong shift has been observed in the valley from the past one or two decades.

KEY WORDS :
Agriculture, Sustainability, Economic prosperity, Agro-ecosystems, Living standard

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BACKGROUND AND OBJECTIVES

Jammu and Kashmir in the recent past was a fully agrarian economy; almost 80 per cent of the population in the Kashmir valley was growing rice and oilseeds for the domestic consumption and for commercial purposes as well. But due to the liberalisation, privatisation, globalisation (LPG), the economies opened up to a greater extent and there occurs a great shift in the rural economies as well. The overall economy in the Kashmir valley has shifted from agriculture to horticulture based enterprises for the attraction of more remuneration in this venture. As per the official records there is also a great variation in the data of different agro-ecosystems as is highlighted in the succeeding headings.

Field crop:

At macro level, the data related to area, production and productivity of field crops in the state show that area in all crops has increased over the years which is like a miracle, because, it is not possible to increase the area in spite of shifting of area to non-agricultural sectors and within agriculture the major shift is found from agriculture to horticulture sector in all the four agro-ecosystems (Table 1).

Rice occupies an important place in the cropping pattern of Jammu and Kashmir. Though rice production is lower in this state compared to other states of India, yet it is the most important crop of the state, especially in the Kashmir valley. Rice alone contributes about 1/3rd to the total food grain production of the state, though since 1970 its share has decreased from about half of the total state's production. The production and productivity have also shown fluctuations during the reference period Table 2. In the year 2000, the production decreased even below the 1971-level, despite recording marginal increase in area, probably due to declining productivity levels. Though its productivity has started increasing but is still below 1980 to 1995 levels. The adoption of HYVs of major cereals in state has risen and the poor SRR in the state has been one of the causes of lower production of HYVs. The macro studies have revealed poor percolation of package of scientific practices of various crops in different agro-climatic regimes in the state. Generally, more seeds are used in principal crops and there is less application of FYM and fertilizers when compared with scientific recommendations.

Fruit crop:

The state has the largest potential for production of quality temperate horticulture crops. It has created niche

Table 1: Area, production and yield of field crops in J&K

Crop	Area (ha)		%	Production (q)		%	Yield		%
	1964-65	2015-16	change	1964-65	2015-16	change	1964-65	2015-16	change
Rice	212000	304503	43.63	4327000	9695440	124.07	18.97	31.84	67.84
Maize	255000	293858	15.24	3718000	5236090	40.83	15.11	17.82	17.94
Wheat	154000	281870	83.03	1122000	5448889	385.64	6.45	19.33	199.69
Pulses	44000	15014	-65.88	253000	92876	-63.29	5.75	6.19	7.65

Source: Digest of Economics and Statistics, Government of J&K (2013-2014 and 2015-16 unpublished)

Table 2 : Area, production and yield of rice in Jammu and Kashmir

Year	Area (000 ha)	Production (000 q)	Yield (q/ha)	Area as % of total net sown area	Production as % of total food grain production
1970	239.95	4578	19.08	34.58	55.8
1975	237.00	4560	19.24	34.16	45.14
1980	264.58	5464	20.65	36.99	41.82
1985	265.55	5871	22.11	36.26	41.83
1990	274.49	5769	21.02	37.56	42.22
1995	273.08	5050	18.49	37.2	34.26
2000	244.05	4153	17.02	32.61	37.09
2005	259.01	5574	21.52	35.3	37.11
2010	259.89	5011	19.28	35.35	42.75
2015	304.50	9695	31.84	41.02	56.20

Source: Digest of Economics & Statistics, Government of J&K (2013-2014 and 2015-16 unpublished)

Table 3: Latest decade change in area, production and productivity of major fresh fruit crops in Jammu and Kashmir

Crop	Area (ha)		% change	Production (MT)		%	Productivity (MT/ha)		% change
	2004-05	2013-14		2004-05	2013-14	change	2004-05	2013-14	
Apple	107925	160865	49.05	1093275	1647687	50.71	10.13	10.24	1.11
Pear	10541	14804	40.44	40250	73515	82.65	3.82	4.97	30.05
Apricot	4932	6441	30.60	11975	17142	43.15	2.43	2.66	9.61
Peach	1940	2547	31.29	2130	7511	252.63	1.10	2.95	168.59
Plum	3391	4761	40.40	3710	10811	191.40	1.09	2.27	107.55
Cherry	2554	3942	54.35	7365	13458	82.73	2.88	3.41	18.39
Other fresh fruits	36285	49335	35.97	58899	71078	20.68	1.62	1.44	-11.24

Source: Directorate of Horticulture Planning and Marketing J&K, "Agriculture Production Department Jammu and Kashmir"

production of apple, pear, cherry and dry fruits. The area, production and yield of fresh fruit crops increase in Kashmir valley (Table 3).

Among temperate fruits, apple ranks first in production and productivity. The annual production of apple in the state is about 9.09 lakh tons with an average productivity of 10.09 tons per hectare. However, the production and productivity of apple remained fluctuating during past two decades, which could be due to changing climatic conditions. In spite of these problems apple production has increased from Just 6000 metric tons in 1950-51 to more than 18 lakh metric tons in 2010-11, productivity is much higher than national level of 6.86 mt/ha and also competes well with the world average of 10.82 mt/ha or china (9.93 mt/ha) which is world highest producer of apple (Table 4).

The area, production and yield of dry fruit crops walnut increase while as for almond it decreases from last decade in Kashmir valley (Table 5).

At macro level, the state has made a commendable progress in fruit and vegetables production indicating that there is a considerable potential in improving the living standard economic status of farming community by ensuring scientific practices in these crops.

Livestock:

The cattle, goats and backyard poultry decreases from 1992 to 2012 but the sheep and poultry bird increases in Jammu and Kashmir Table 6. While as the livestock census of 1992. Table 7 reveals that district Anantnag has higher population of cattle, sheep, goats and backyard poultry followed by Pulwama besides a very small population of equines. The livestock census of 2012 reveals that again district Anantnag has higher population of cattle, sheep, goats and backyard poultry followed by Pulwama but district Budgam has higher

Table 4: Area, production and yield of apple in Jammu and Kashmir

Year/Crop	Apple			Total fruit		
	Area (ha)	Production (tons)	Y (MT/ha)	Area (ha)	Production (tons)	Y (MT/ha)
2000-01	88149	751310	8.523182	219034	931800	4.25
2005-06	111881	1151712	10.29408	268284	1412992	5.26
2010-11	141717	1852412	13.07121	325075	2221992	6.83
2013-14	160865	1647687	10.42	355092	2073948	5.84

Source: Directorate of Horticulture Planning and Marketing J&K; Agriculture Production Department, Jammu and Kashmir

Table 5: Latest decade change in area, production and productivity of major dry fruit crops in Jammu and Kashmir

Crop	Area (ha)		%	Production (MT)		%	Productivity (MT/ha)		%
	2004-05	2013-14	change	2004-05	2013-14	change	2004-05	2013-14	change
Walnut	74894.00	95601.00	27.65	100596.00	220589.00	119.28	1.34	2.31	71.79
Almond	15433.00	15982.00	3.56	13473.00	11815.00	-12.31	0.87	0.74	-15.32
Other dry fruits	416.00	815.00	95.91	188.00	344.00	82.98	0.45	0.42	-6.60

Source: Directorate of Horticulture Planning and Marketing J&K; Agriculture Production Department, Jammu and Kashmir

Table 6: Size and growth in livestock population in Jammu and Kashmir (lakhs)

Species	Quinquennial livestock census					Per cent growth rate			
	1992	1997	2003	2007	2012	1992-97	1997-03	2003-07	2007-12
Livestock	131.25	134.47	151.45	149.66	125.04	2.39	12.63	-1.18	-16.45
Cattle	30.54	31.75	30.84	34.43	27.98	3.81	-2.87	11.64	-18.73
Cross cattle	7.92	10.84	13.20	16.77	14.70	26.94	21.77	27.05	-12.34
Local cattle	22.62	20.92	17.61	17.66	13.29	-8.13	-15.82	0.28	-24.75
Sheep	29.47	31.68	34.09	41.27	33.89	6.98	7.61	21.06	-17.88
Goat	17.66	18.10	20.55	20.68	20.18	2.43	13.54	0.63	-2.42
Backyard poultry	46.29	55.25	55.69	42.78	33.04	16.22	0.80	-23.18	-22.77

Source: Digest of Economics and Statistics, Govt. of J&K (2013-14)

population of goats and backyard poultry than Pulwama. The data show that the total livestock population is decreased from 131.25 (1992) to 125.04 (2012), but the sheep population is increased in district Pulwama and Budgam.

The livestock density presented in the Table 8 revealed a decline from 172 animals/sq km (1992) to 126 animal/sq km (2012) and the density of cattle has shown yet more decline from 94/sq km in 1992 to 76/sq km in 2012 in the Kashmir valley. On the other hand, the sheep goat population grew significantly in all the regions.

In Pulwama district the number of livestock which had been increasing until quinquennial census of 1997, later it declined at the rate of 4.56 per cent annually. Cattle production system in the district is mainly cross bred and local hill cattle based. The total cross bred sheep population increased faster than the indigenous sheep cattle population in the erstwhile Pulwama decreased between 1992 and 2003 and increased from 1.89 lakhs to 1.99 lakhs at a compound annual growth rate of 1.04 per cent between 2003-2007. This shows that cattle population in the district is adapting to technological, environmental and commercial interventions for output quality and quantity (Table 9).

Rural infrastructure:

The importance of good infrastructure for agricultural development is widely recognized and government spending on rural infrastructure has significant impact on agricultural growth and rural poverty alleviation. The growth pattern of road network and road density in J&K revealed that the total road length has increased since 1980-81 (Table 10). The surfaced (quality) roads have shown a rapid expansion during this period. Increasing road density is a positive sign of economic development in the state. The development of roads across the districts/regions and inaccessible areas to exploit niches in the areas, could help improve the economy of the area/region. In J&K, only 55 per cent villages were electrified till 1980-81 and upto early-2000s electricity supply was extended to 97 per cent of villages. However, the duration of electricity supply in the state is a matter of concern. The consumption of electricity for agricultural purposes in the state has increased

Table 7: District-wise size and growth in livestock population in Jammu and Kashmir (lakhs)

Region/District	Quinquennial livestock census					Per cent growth rate			
	1992	1997	2003	2007	2012	1992-97	1997-03	2003-07	2007-12
Anantnag	15.08	15.58	13.25	13.25	9.44	3.32	-14.96	0.00	-28.75
Pulwama	9.42	10.88	8.13	7.10	5.48	15.50	-25.28	-12.67	-22.82
Budgam	7.67	9.37	7.33	6.52	5.89	22.16	-21.77	-11.05	-9.66
Srinagar	4.45	6.04	5.38	5.85	4.40	35.73	-10.93	8.74	-24.79
Baramulla	12.37	13.5	13.06	15.49	13.24	9.14	-3.26	18.61	-14.53
Kupwara	7.41	8.95	7.51	9.90	8.35	20.78	-16.09	31.82	-15.66
Kashmir	56.40	64.32	54.66	58.11	46.81	14.04	-15.02	6.31	-19.45
Jammu	68.76	67.52	90.50	85.24	70.68	-1.80	34.03	-5.81	-17.08
Ladakh	6.09	2.63	6.29	6.32	7.56	-56.81	139.16	0.48	19.62
Percentage	131.25	134.47	151.45	149.66	125.04	2.45	12.63	-1.18	-16.45

Source: Digest of Economics and Statistics, Govt. of J&K (2013-14)

Table 8 : Density of livestock in different districts of J& K (density in per sq km of geographical area)

District/region	Cattle		Buffalo		Sheep		Goat		Poultry	
	1992	2012	1992	2012	1992	2012	1992	2012	1992	2012
Anantnag	93	92	2	1	84	64	8	8	193	80
Pulwama	192	137	4	2	122	132	16	8	338	112
Budgam	147	109	0.8	0	103	129	15	24	293	166
Kashmir region	94	76	2	1	73	70	12	14	172	126
Percentage	14	13	3	3	13	15	8	9	21	15

Source: Digest of Statistics, Government J&K (2013-2014)

significantly over the years. Although the number of pump sets energized has increased.

Transition:

Field crop:

Rice occupies an important place in the cropping pattern of Jammu and Kashmir. Though rice production is lower in this state compared to other states of India, yet it is the most important crop of the state for being staple food, especially in the Kashmir valley. Rice alone contributes about 1/3rd to the total food grain production of the state, though since 1970 its share has decreased from about half of the total state's production. The decline could probably be due to better performance of other cereals like wheat and maize in Jammu and Ladakh divisions of the state. The production and productivity have also shown fluctuations during the reference period. In the year 2000, the production had decreased even below the 1971-level, despite recording marginal increase in area, probably because of decline in productivity levels. The fluctuating production could also be attributed to the occurrence of frequent natural calamities like draughts, floods and hailstorms. The data reveal that the area under rice in the state has steadily increased from about 240 thousand hectares in 1970 to about 274 thousand hectares in 1990 and then declined to 244 thousand hectares in 2000 but gained momentum of increase and rose to about 260 thousand hectares in 2010. Such a decline was due to diversification towards horticultural crops and shifting of agricultural land to non-agricultural purposes.

Fruit crop:

The state has the largest potential for production of quality temperate horticulture crops. It has created niche production of apple, pear, cherry and dry fruits. Among temperate fruits, apple ranks first in terms of production and productivity. The annual production of apple in the state is about 9.09 lakh tons with an average yield of 10.09 tons, per hectare. However, the production and productivity of apple crop has been fluctuating during last two decades, which could be due to drought or unusual climatic changes. In spite of this apple production has increased from just 6000 metric tons in 1950-51 to more than 18 lakh tons in 2010-11, productivity is much higher than national level of 6.86 mt/ha and is comparable with the world average of 10.82 ton/ha or china (9.93 ton/ha) which is the world highest producer of apple. In the southern districts of Kashmir Shopian constitutes the highest production of apple with 1,96,191 mt in 2009-10, contributing 96.15 per cent of total fresh fruits. The increase in production was due to area shift from other crops towards apple. The district contributes about 17 per cent of total apple production in Kashmir valley covering of 16 per cent of total apple orchards in the valley. The productivity of Anantnag and Pulwama in 2009-10 was 7.99 8.04 and 11.94, respectively, which was also higher than national level.

Livestock:

In Jammu and Kashmir, livestock plays a significant role and contributes 13 per cent to the state gross domestic product (SGDP). The state has a total livestock population of 12.504 crore with human and animal ration of 0.98. The livestock products *viz.*, Pashmina, carpet and other important handicrafts are an important source of foreign exchange earnings. As per provisional

Table 9: Size (lakhs) and growth in Pulwama

Species	Quinquennial livestock census					Per cent annual growth			
	1992	1997	2003	2007	2012	1992-97	1997-03	2003-07	2007-12
Livestock	9.42	10.88	8.13	7.10	5.48	2.92	-5.66	-2.67	-4.56
Cattle	2.68	2.12	1.89	1.96	1.87	-4.58	-2.27	0.73	-3.53
Cross cattle	1.41	1.63	1.71	1.89	1.82	2.94	0.96	2.02	-0.74
Local cattle	1.27	0.49	0.19	0.07	0.05	-17.34	-17.26	-18.10	-5.71
Buffalo	0.06	0.10	0.00	0.03	0.03	10.76	0.00	0.00	0.00
Small ruminants	1.96	2.3	1.73	2.20	1.95	3.25	-5.54	4.92	-2.27
Sheep	1.73	1.97	1.38	1.98	1.84	2.63	-6.87	7.49	-1.41
Goat	0.23	0.33	0.35	0.22	0.11	7.49	1.18	-8.87	-10
Backyard poultry	4.72	6.44	4.52	2.91	1.57	6.41	-6.84	-8.43	-9.21

Source: Digest of Statistics, Government J&K (2013-2014)

estimates of 19th livestock census 2012, total livestock population in the state has registering a decrease of 16.45 per cent. The number of livestock per 1000 of human population as per livestock census 2012 is 10000 animals. The contribution of livestock sector of Kashmir valley was 775.91 crore rupees during the year 2003-04. Out of these Rs. 690 crore from milk, Rs. 38.8 crore from eggs, Rs. 17.1 crore from poultry meat and Rs. 30 crore from farm yard manure. Besides, 5.6 million poultry are contributing 63.2 million eggs per annum. Small ruminants comprising 3.4 million sheep and 2 million goats also contribute significantly to the total livestock population of the state. The state also has highest population of about 47,000 yaks in the country. Despite all this, the milk production in the state is low and is less than even the northern states. Farmers still take it as a means of subsistence. Livestock population which are numerically important in terms of contribution to livestock output includes cattle, buffalo (bovines), sheep and goats (small ruminants), backyard poultry and numerically less important in number are equines like horses, pony, donkey and camels etc. The data show that the total livestock population is decreased from 1992 to 2012. But the sheep and goat population is increased in district Pulwama and Budgam.

The livestock intensity in the state has increased from 86 animal/sq km in 1992 to 98 animals/sq km of geographical area in 2003. The increase in proportion of some species and a decrease in the others seem to have influenced the speed of intensification in the state. The livestock density exhibited considerable variation across different regions of J&K. The growth of livestock intensity had declined from 186 animals/sq km (1992) to 166 animal/sq km (2003) and the density of cattle had declined from 94/sq km in 1992 to 81/sq km in 2003 in the Kashmir. On the other hand, the density of other animals showed a small increase in all the regions of J&K. The density of poultry too has increased in all the regions. Cattle population increased in Jammu and Ladakh region but declined in Kashmir. The buffalo population, in the Kashmir declined significantly at an annual growth rate of 14 per cent. The sheep and goat population grew significantly in all the regions. To sum up, the increase in livestock intensity in the state was experienced due to intensification of livestock, especially higher population indicating that this region has better availability and access to resources like feed and fodder and has comparative advantage in livestock production. Increasing intensification of livestock depicted a good picture from the point of view of availability of livestock products. The sustainability issue of livestock production system, in respect of increasing livestock population, did not seem to pose a challenge, though appropriate species-mix and enhancing productivity of livestock animals still remain a major challenge. However, this intensification has raised the issues of sustainability in the state in respect of decreasing holding size and pasture areas.

In Pulwama the livestock number which had been increasing until quinquennial census of 1997 has started declining and between census of 2007 and 2012 it registered a decline of 4.56 per cent annually. Cattle production system in the district consists of both cross bred and indigenous breeds of hill region. The total cross bred sheep population has increased significantly over the years. Cattle population in the erstwhile Pulwama decreased between 1992 and 2003 and increased from 1.89 lakhs to 1.99 lakhs at a compound annual growth rate of 1.04 per cent between 2003-2007, thereafter, declined to 1.84 lakhs in 2012. This shows that cattle population in the district is adapting to technological, environmental and commercial interventions for output quality and quantity (Table 9). The crossbreeding programme in cows has increased the productivity of indigenous breeds of cattle. The effort for increasing milk production is well re-organized in the district. Top priority is given to crossbreeding programmes by introducing germ plasm of Jersey, Holstein Friesian, Brown Swiss and Red Dane breeds for the improvement in the stock.

Table 10: Development of road network and village electrification in Jammu and Kashmir (1980-81 to 2009-10)

Year	Total road length		Village electrification	
	(km)	% decadal change	(%)	% decadal change
1980-81	8206	-	55.42	-
1990-91	11838	44.26	93.24	37.82
2000-01	13660	15.39	95.83	2.59
2009-10	20016	46.53	96.48	0.65

Source: Digest of Statistics 2013-2014, Planning and Development Dept., Government of Jammu and Kashmir

Dairy farming is becoming a commercial activity in the district and the elite farmers have brought notable changes in composition of herd size, with better quality of dairy animals. This phenomenon is triggering growth in cross bred cattle population leading to deceleration in local cattle population in the district. The contribution of buffalo in the district was negligible.

Sustainability:

To provide an overview of major factors affecting agricultural sustainability in the Kashmir valley and associated challenges that must be overcome to achieve long-term sustainability. In Kashmir Valley, the depth of poverty and hunger is already great and environmental degradation is further reducing the productive resource capacity. Thus, measures to be taken in the future for gains in food security requires clear, effective and synergetic strategies for sustainable agriculture and environmental conservation. The data reveal that the area under rice in the state has steadily increased from about 240 thousand hectares in 1970 to about 274 thousand hectares in 1990 and then declined to 244 thousand hectares in 2000 but has again rose to about 260 thousand hectares in 2010 and later increased to 262 thousand hectares in 2013. Such a decline was due to diversification towards horticultural crops and shifting of agricultural land to non-agricultural purposes. (Weinberger and Thomas, 2007) have highlighted the growing importance and demand of horticultural crops due to increasing income levels, changing life styles, urbanization and contribution of horticulture crops in reducing poverty and increasing economic development via employment generation and income augmentation. (Bazaz and Haq-Imtiyaz-ul-Haq, 2013), stated that due to the stagnant growth in agriculture sector and low commercial value of staple crops farmers have made their intensions clear about the shifting of the agriculture sector to horticulture production. Diversification towards horticulture has become a viable option to stabilize growth and increase farm income and enhance agriculture growth. The diversification towards horticulture for improving sustainability, profitability and productivity will help not only in improving farm income but will generate gainful employment. It is believed that horticulture sector can be promoted as a means of agro-diversification for second green revolution in India. Under conventional agriculture, humans have simplified the structure of the environment over vast areas, replakhing natural diversity with a small number of cultivated plants and domesticated animals (Buck *et al.*, 2004). This artificial ecosystem needs constant human intervention in planting site preparation, planting, and use of agrochemicals to control weed and different pests and manipulation of crop genetics (Altieri, 1995).

Increases in agricultural productivity have, come in part, at the expense of deterioration of the natural resources base on which farming systems depend. Deforestation, loss of the germ plasmas of traditional crops and extinction of plant and animal species has threatened the production of quality and quantity of food and raw materials for the subsistence farmers.

Conversion of natural ecosystems to agricultural production accelerates soil erosion, acidification, primarily as a consequence of base depletion from crop removal, increased organic matter decomposition and the application of ammonium-based nitrogen fertilizers (McCool *et al*., 2001). Sustainable production of crops, livestock and wood products depend on systems of land use that maintain soil fertility and reduce erosion and other kinds of degradation. Efforts to improve soil fertility include livestock production, efficient use of crop residue and manure and introduction of herbaceous, tree forage legumes that can fix atmospheric nitrogen. Long-term sustainable development of agriculture ranges from the maintenance of a supportive biophysical resource base, the economic viability of production, and the continuation of a sufficient supply of agricultural products, to the social vitality of agriculture-based rural communities (Xu and Mage, 2001).

Combining trees with agricultural crops or livestock will achieve the objectives of sustainability, increased production and benefits to the rural poor. Trees and shrubs are the very important components of the farming systems, which provide the local communities with wood products for domestic use and income generation, environmental protection, land productivity improvement, shelter and shade.

Altieri (1995) states about 60 per cent of the world‘s cultivated land is still farmed by traditional and subsistence methods. The traditional use of biologically diverse resources not only reflects a varied resource-use pattern, but also variety in the methods of maintaining biological diversity in ecosystems. Many of these agro-ecosystems are small-scale, geographically discontinuous and located

on a multitude of slopes, aspects, microclimate, elevation zones and soil types. This artificial ecosystem needs constant human intervention in planting site preparation, planting and use of agrochemicals to control weed and different pests and manipulation of crop genetics. Further, agriculture provides the great bulk of food supporting people on Earth. Despite a very high percentage of terrestrial primary production being devoted to this cause, 700-800 million people still lack adequate access to food.

(Allen and Sachs, 1991) states sustainable agro-ecosystems will then, reflect patterns of succession, energy flow and nutrient cycling similar to natural ecosystems. Sustainable agriculture constitutes an important, progressive alternative to conventional agriculture, which reduces environmental degradation, preserves or restores the family farm and removes contamination from human consumption.

(Gliessman, 1998) states the characteristics of sustainability include, at the very least: Having minimal negative effects on the environment and releasing no toxic or damaging substances into the atmosphere, surface water or ground water, preserving and rebuilding soil fertility, preventing soil erosion, maintaining soils and ecological health; Using water in a way that allows aquifers to be recharged and the water needs of the environment and people to be met, relying mainly on resources within the agro-ecosystem, including nearby communities, by replacing external inputs with nutrient cycling, better conservation and an expanded base of ecological knowledge; Working to value and conserve biological diversity, both in the wild and in domesticated landscapes and guaranteeing equality of access to appropriate agricultural practices, knowledge and technologies and enabling local control of agricultural resources.

(Vance, 2000) argues that tillage alters the physical and chemical characteristics of the soil, and this will profoundly affect the growth, functioning and survival of the soil biota. Maintaining soil quality is very important for sustainable production, which can be influenced by the contents of organic matter, fertility, physical properties and microbial process soil degradation is a major environmental problem worldwide and there is strong indication that the soil degradation processes cause an immediate threat to both biomass and economic yields of agriculture, as well as a long-term risk to future crop yield.

(Howarth and Farber, 2002) reported that valuation is useful in settings where institutional arrangements are not functioning well to reflect the social cost of environmental degradation. The recognition of the market failings and their impacts on poverty has placed sustainable development at the forefront of the global agenda through the 1992 Earth Summit and the subsequent 2002 World Summit on Sustainable Development (WSSD). The outcome of the WSSD was a 'commitment' by the international community to a plan of implementation regarding sustainable development. Fundamental to this commitment are three main challenges: the eradication of poverty, changing patterns of consumption and production, and protection and management of the natural resource base for economic and social development (United Nations, 2002).

(Francis *et al.*, 2003) argues that agro-ecology is the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions. It shows how natural systems can be used as templates or models for developing agricultural systems, which increase productivity and sustainability of agriculture while maintaining an environment that endures as well as provides quality of life. Therefore, agriculture will necessarily be composed of polycultures designed to benefit from spatial, seasonal and nutritional complementarity among species and draw largely on studies of plant interference and facilitation in natural communities.

(Pagliai *et al.*, 2004) points out that reduction in soil structure degradation is one of the main aims of land management to minimize the impact of agricultural activities on the environment. An important component of sustainable land management is the management of soil and plant nutrients. Soil fertility can be improved by managing nutrient stocks, organic matter content and flows.

(Tesfaye, 2005), defines sustainable agriculture as the management and conservation of the resource base and the orientation of technological and institutional changes in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Sustainable agriculture is a type of adaptation management encompassing a number of technologies, which together will produce high yields in a more sustainable manner than industrialized agriculture. Many technologies are based on and use ecological functions and services already existing in the agro-

ecosystem. Sustainable development is environmentally none degrading, technically appropriate, economically viable and socially acceptable.

(Tesfaye, 2005) points out home gardens are the most complex and diverse agro-ecosystems which fulfill ecological functions and economically more viable than other land use systems in the tropics because of the high-value cash crops comprised in them. Sustainable agricultural development is influenced by socio-economic and biophysical environments, resource endowment and production objectives.

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