Ever increasing human population has exerted a strong pressure on the availability of land on the one hand and a reduction in production of crops required for human consumption (Yadav & Kumar, 1998). Intercropping system by intensification of cropping both in time and space gives a yield advantage of 11 to 199 % over sole cropping through effective use of natural (i.e. land, light) and added (fertilizer) resources (Sharma et al., 2003).

However, success and efficiency of an intercropping system depend upon various factors. Benjamin et al. (2000) opined that intercropping system is greatly influenced by the component or associated crops, though profitability is favoured by choice of sites with a high fertility, use of proper package of practices etc. According to Willey (1979), optimizing the crop performance in an intercrop system is a question of maximizing complementarity and minimizing the competition between the two component crops. It may, therefore, be worthwhile to test different crops for their suitability as intercrop. Nowadays, there is an increasing demand for natural herbs because of the hazardous side effects of many of the chemical substitutes. Hence, the trade of medicinal and aromatic plants like Stevia (Stevia rebaudiana (Bertoni) Hemsl.), Patchouli (Pogostemon cablin Benth.) and Brahmi (Bacopa monnieri (L.) Wett.) etc. is flourishing at very rapid rate. Similarly, spices like Ginger (Zingiber officinale Rosc.), Turmeric (Curcuma longa L.), Garlic (Allium sativum L.) are high valued and have high demand in domestic as well as export markets. Tuber crops like Colocasia (Colocasia esculenta Schott.), Potato (Solanum tuberosum L.), Onion (Allium cepa L.) also have great importance in NER and grown everywhere in the region. Although sufficient work has been done on intercropping, not much attention has been paid to intercropping in existing Som plantation in a systematic way. Moreover, little work has been done so far to evaluate spices, medicinal plants and tuber crops under intercropping systems.
A brief review of work done in India and abroad pertaining to performance of associated crops under intercropping system, effect of component crops on main crop and the economic feasibility of intercropping system in terms of total production, land equivalent ratio and economics have been described in this chapter. So far, limited information is available on intercropping in Som plantation and that so is available during gestation period of Som only, but literature on intercropping in established fully grown Som plantations utilizing diffused sunlight of the interspaces is not available. Hence, the review is made to cover the work done in intercropping of different component crops viz., Ginger, Turmeric, Garlic, Patchouli, Stevia, Brahmi, Colocasia, Potato and Onion with other Sericultural, Horticultural or Forest plants.

2.1 Growth and yield of main crop in intercropping system

Intercropping of Ginger and Turmeric in the plantations of Coconut (Cocos nucifera L.) and Areca nut (Areca catechu L.) was reported by Mandal and Magoon (1964) and later on Nelliat et al. (1974). They found no adverse effect on the growth and yield of Coconut when both main crops and intercrops were adequately and separately fertilized. The results of an investigation conducted in eastern parts of Himalayas (Anonymous, 1988) showed high return and no adverse effect of Ginger and Turmeric as intercrops on the growth of Guava (Psidium guajava L.). Chinnamani (1990) reported Ginger and Turmeric as the best intercrops in Mandarin (Citrus reticulata Blanco.) orchard. Similarly, Gupta (1990) reported Turmeric as the best intercrop in Peach (Prunus persica (L.) Strokes.) and Chillies (Allium sativum L.) in Eureka lemon (Citrus limon (L.) Burm. f. orchard in Doon Valley. Reddy and Biddappa (2000) reported that the Coconut yield increased from 120 nuts to 180 nuts /palm/year when intercropped with Turmeric. The yield of Mango (Mangifera indica Linn.) was not affected by the multistorey cropping with Bay (Cinnamomum tamala (Buch.-Ham.) T. Nees & Eberm.), Black pepper (Piper nigrum L.), Pineapple (Ananas comosus L. Merr.) and Ginger (Zingiber officinale Rosc.) as reported by Awasthi and Saroj (2004). Intercropping of Ginger and Turmeric in Coconut and Areca nut plantations was also reported by Sasikumar (2005). Vishwanath et al. (2007) recommended Ginger as more
viable intercrop in Bamboo (Bambusa spp.) plantation than monoculture of Bamboo or Ginger.

Intercropping of Potato with sugarcane (Saccharum officinarum Linn.) was found profitable by many workers (Kanwar, 1975; Verma et al., 1986 and Singh et al., 1986). Similarly, raising of Potato as intercrop in Coconut and Coffee (Coffee arabica L.) gardens was found to be profitable by Rethinam (1989) and Njoroge et al. (1989) respectively. Shanthamallaiah et al. (1982a) recorded 14.51% increase in coconut yield when Potato was grown as intercrop with Coconut. An increase in yield of coconut to 111.2 nuts/palm from 98.7 nuts/palm indicating productivity improvement of 12.6% was also reported by Hedge (1997) when vegetables like Brinjal (Solanum melongena L.), Bhindi (Abelmoschus esculentus (L.) Moench.), Tomato (Lycopersicon esculentum Mill.) etc. were grown in the interspaces of Coconut. The size of Coffee bean and quality of roast and liquor were not significantly affected by Potato as intercrop at Ruiru in Kenya rather it gave positive net economic benefits (Njoroge et al., 1989). Highest tiller, millable cane, maximum length, diameter, unit stalk weight and better yield of Sugarcane were reported when Sugarcane was grown with Potato (Miah et al., 1994; Muhammad et al., 2000 and Hussain et al., 2003). Better yield of Sugarcane was due to beneficial effects of applied fertilizers, manures and crop management for Potato as reported by Hussain et al. (2003).

Onion was suggested as intercrop for achieving higher cane yield as well as to get interim benefit from a same piece of land. As intercrop, Onion did not show any adverse effect on growth and yield of Sugarcane but it produced minimum number of tiller because of more competition of the crop for nutrient and water. However, Sugarcane with Onion produced maximum economic return (Hussain et al., 2003).

Moreover, Sericulture with field crops (French bean Phaseolus vulgaris L., Groundnut Arachis hypogaea L. Mustard Brassica juncea (L.) Czern. /vegetables) for valley land, with fruit plants (Guava, Pineapple) and grasses for mid-hill situations and with Rice (Oryza sativa L.) for low lands were found to be suitable by several workers. Between rows of Mulberry (Morus alba L.) plantation, a number of vegetables like Onion Allium cepa L., Tomato Lycopersicon esculentum Mill., Brinjal Solanum melongena L., Lady’s finger Abelmoschus esculentus (L) Moench., French bean Phaseolus vulgaris L. etc., cereals like Maize Zea mays L., legumes like Soybeans
Glycine max (L.) Merrill. Green gram Phaseolus radiatus L. etc. (Shankar et al., 1998, Yadav & Kumar, 1998 and Mane et al., 2000) can successfully be grown without affecting Mulberry leaf yield and silkworm rearing (Ramamurthy & Prasad, 2006) again recommended Marigold (Tagetes patula L.) followed by Chick pea (Cicer arietinum L.) as the most economical intercropping system with Mulberry. No significant effect in leaf yield of sole or intercropped mulberry was reported by Anonymous (1995) and Bongale et al. (1998). Shanthamallaiah et al. (1982 b) reported an increase in the yield of Coconut by 920 nuts /ha when Mulberry was grown as a mixed crop with Coconut. Again, Meerabai et al. (2002) undertook an investigation at Kerela and assessed the performance in productivity and quality of Mulberry grown as intercrop in Coconut garden. They reported reduction in leaf yield of Mulberry due to the reduction in the availability of photosynthetically active radiation (PAR). However, net profit obtained from the Coconut garden was more than that of sole cropping of Coconut. With the same doses of fertilizers and FYM application resorted to sole crop of Mulberry, intercropping of Turmeric revealed 8.47% decrease in leaf yield of Mulberry than that of sole Mulberry (Tikader, 1991).

According to Debnath (1992), legume crops are suitable as intercrop during gestation period of Som (Persea bombycina Kost.) which increases production and quality of leaves besides improving soil nutrient status. Pamehgam et al. (2000) conducted another experiment during gestation period of Som and recommended Colocasia as suitable intercrop for summer season. Similarly, for winter season, they suggested Potato and Tomato as profitable intercrops. Cultivation of vegetables like Lady’s finger (Abelmoschus esculentus (L.) Moench.), brinjal etc. as intercrop in Som gardens during gestation period improved soil condition, generated additional income and cultural operations carried out for intercropping facilitated growth of the main crop as reported by Suryanarayana et al. (2002). Phukan et al. (2008) reported that Mulberry fetched an additional income to the regular Muga silkworm crops without any adverse affect on the quality and production of both foliage of Som and cocoons of Muga silkworm when it was intercropped in the existing Som trees. Further, they reported that leaf yield of Som increased by 10-11 per cent due to intercropping of Mulberry which in turn increased rearing capacity of Som and enhanced muga cocoon production. The gross net income from Muga and Mulberry integrated culture was
accounted to be 64.67 per cent more against mono Muga culture and 51.81 per cent more to that of mono Mulberry culture.

Bandyopadhyay et al. (2004) evaluated the performance of six Colocasia germplasm lines (BCC-23, Ce-6, Jhankri, Nadia Local, Kadma Local and C-62) as intercrop in young Arecanut (Areca catechu L. cv. Mohitnagar) plantation and their effects on the growth of the main crop at Nadia, West Bengal. It was found that Colocasia grew successfully as intercrop in the young Arecanut plantation without hampering its growth. An increase in yield of Coconut by 30.3 per cent with Colocasia was earlier reported by Reddy and Biddappa (2000).

Removal of up to 50% of canopy cover and installation of root barriers on either side of the rows of Casuarina (Casuarina equisetifolia L.) had no significant difference in overall growth performance of Casuarina (George et al., 2004). Joomjantha and Wanapat (2008) reported significant increase in Cassava (Manihot esculenta Crantz.) foliage yield over control when Sweet Potato (Ipomoea batatas L.) was grown as intercrop with Cassava. Again, in France, Chifflot et al. (2006) and in Quebec, Rivest et al. (2009) observed that above ground biomass of Poplar (Populus deltoids Marsh.) associated with various annual intercrops was 40% greater than that observed under Poplar monoculture. According to this study, improvement in growth of Poplar comes due to effect of intercropping on stimulating soil microbial biomass, mineralization of nitrogen and recovery of fertilizer residue by Poplar roots.

The beneficial effect of intercropping Garlic with sugarcane was reported by Ahmed et al. (2008). According to him, intercropping of Garlic increases germination of sugarcane.

In Assam, Saud et al. (2009) carried out an experiment by growing medicinal and aromatic plants in Coconut garden. They reported that intercropping of Patchouli in Coconut garden is co friendly and highly remunerative which increases the productivity of the farm land by 231.68% producing per hectare Coconut equivalent yield of 23, 529.54 numbers and a net income of ₹1,31,934.80.

In Arecanut garden of Karnataka, Channabasappa et al. (2007) recommended Stevia as suitable and financially viable intercrop.
2.2 Growth and yield of associated crops in intercropping

It is well-known fact that young hardwoods generally cause only a negligible loss of productivity in associated crops; this effect could even be beneficial in some cases. However, as time passes, intercrops could suffer from competition with trees for light, water and nutrients in the soil. In Quebec and Ontario, studies have shown reduction in yield of Soybeans and Corn or Maize (*Zea mays* L.) as a result of tree shade (Reynolds et al., 2007; Rivest et al., 2009). However, the effect of shade is not always exhibit a decrease in the yield of the associated crops. Some forage plants can, under partial shade (i.e. 50%), produce a total biomass and protein content greater than those observed in full light (Lin et al., 1999). In Ontario, Clinch et al. (2009) also observed improved performance of a Willow (*Salix reticulata* L. *nivalis* Hook) crop under moderate shade compared with the same crop grown in monoculture. In the United States, some research have shown that tree competition for water can become critical to the point of significantly decreasing the productivity of the associated crops (Jose et al., 2004). However, it is possible to neutralize this competition by undertaking tree root pruning *i.e.* by mechanically controlling tree roots to prevent them from extending into the crop area. The few trials that have studied competition for nutrients in the soil have proven this competition to be generally negligible in that the nutritional requirements of intercrops are normally met through standard fertilization practices (Miller & Pollardy, 2001).

2.2.1 Growth and yield of Ginger (*Zingiber officinale* Rosc.) as intercrop

Ginger as a profitable intercrop in between Mandarin trees was reported by Anonymous (1988), Singh and Pradhan (1989) and Patiram *et al.* (1994). The investigation conducted in eastern parts of Himalayas (Anonymous, 1988) resulted high net return when Guava was grown with Ginger. Ginger as intercrop with Mandarin yielded 609 kg rhizome/ha (Singh & Pradhan, 1989). According to Patiram *et al.* (1994), Ginger takes maximum advantage of the space in between Mandarin and generates high economic returns.
Dhyani and Chauhan (1989) studied the performance of Ginger under natural shade of *Pinus khasya* Royle ex Gordon. (Khasi Pine) on 40% slope in Khasi hills (Meghalaya). They reported higher yield of Ginger in partial shade as compared to open condition and complete shade of *Pinus khasya*. In intercropping with Coconut also, Ginger produced higher yields as compared to open space (Jayachandran *et al*., 1991). Jayachandran *et al*. (1998) reported 32% increase in rhizome yield of Ginger under natural shade of Coconut compared to open space. In Bangladesh, Ginger produced a yield of 4.33 t/ha when grown under shade of juvenile (8-10 years old) Mango trees (Haque *et al*., 2004).

When intercropped with Poplars, Ginger performed better in respect of survival, plant height, tillers per plant, leaves per plant, rhizome length, rhizome breadth, yield per plant and yield per hectare than as pure stands (Jaswal *et al*., 1993). Higher nutrient uptake in Ginger under shaded situation was reported by Ancy & Jayachandran (1998). Thanuja (2001) reported that shading reduces soil and air temperature and thereby reduces the overall water requirement of the crop. Significant improvement in morphological and yield attributing features of ginger (*viz.*, plant height, number of leaves per plant, number of fingers per rhizome, length and weight of single finger and single rhizome weight) due to shading of Som (*Persea bombycina* Kost) was reported by Hazarika *et al*. (2009). In the same study, full sunlight in open condition resulted scorching in leaves of Ginger, less morphological growth and less production of rhizomes from a unit area of land.

2.2. II Growth and yield of Turmeric (*Curcuma longa* L.) as intercrop

Intercropping of Turmeric in Coconut plantation was reported by various workers (Mandal & Magoon, 1964; Nelliat *et al*., 1974; Jayachandran *et al*., 1991; and Bandyopadhya *et al*., 2004). Intercropping of Turmeric with Maize and Rice (Kundu & Chatterjee, 1981), under natural shade of *Pinus khasya* (Dhyani & Chauhan, 1989), with Mulberry (Tikader, 1991), with Poplars (Jaswal *et al*., 1993), in initial stages of Bamboo plantations (Shanmughavel & Peddappaiah, 2000), with *Casuarina equisetifolia* (George *et al*., 2004), under shade of Mango trees (Haque *et al*., 2004) and with Som plants (Hazarika *et al*., 2009) were also reported.
Higher yields of Turmeric as intercrop with Coconut compared to open space were reported by Jayachandran et al. (1991). Higher yields in partial shade as compared to open condition and complete shade were also reported by Dhyani and Chauhan (1989) who studied the performance of Turmeric under natural shade of Pinus khasya in Khasi hills of Meghalaya. Turmeric performed better as intercrop with Poplar than as pure stands in respect of survival, plant height, leaf length and leaf breadth (Jaswal et al, 1993). Gangadharan and Menon (2003) stated that lesser amount of shade helps in promoting higher yield in Turmeric. Removal of up to 50% of canopy cover and installation of root barriers on either side of the rows of Casuarina had positive effects on yield of Turmeric crop (George et al., 2004). Turmeric grown under shade of juvenile (8-10 years old) Mango trees in Bangladesh produced high yield of 11.66 t/ha (Haque et al., 2004). Significant improvement in morphological and yield attributing features of Turmeric (viz., plant height, number of leaves per plant, number of fingers per rhizome, length and weight of single finger and single rhizome weight) under Som plants were also reported by Hazarika et al. (2009) than in open condition which resulted scorching in leaves of Turmeric, lesser morphological growth and less production of rhizomes from a unit area of land.

However, Kundu and Chatterjee (1981) opined that Turmeric in intercropping should be fertilized with more nitrogen than the recommended dose for sole cropping. With the same doses of fertilizers and FYM application resorted to sole crop of Mulberry, intercropping of Turmeric revealed 8.47% decrease in leaf yield of Mulberry than that of sole Mulberry but 10.98% increase in yield of Turmeric rhizome than that of sole Turmeric (Tikader, 1991).

2.2. III Growth and yield of Garlic (Allium sativum L) as intercrop

The performance of Garlic as a high value crop under Poplar plantation was studied by Dhiman and Gandhi (2009) at Uttrakhand. They observed morphological parameters of Garlic (like bulb length, weight of bulb, number of cloves, weight of cloves, average weight of clove and yield of cloves) and recommended that Garlic could be grown profitably under Poplar plantation.
2.2. IV Growth and yield of Stevia (Stevia rebaudiana Bertoni) as intercrop

Cultivation of Stevia as an intercrop has earlier been reported in Arecanut gardens (Channabasappa et al., 2007) and under shade of Teak tree (Sharanabasappa, et al., 2007). In Karnataka, Channabasappa et al. (2007) found similar stevioside content of Stevia in both open and Arecanut shaded conditions. However, they reported a decrease in height, number of leaves and economic yield of Stevia under Arecanut shade due to decreased light intensity compared to open field. Under shade of Teak tree in Sirsi taluk, Uttara Kannada district, Sharanabasappa et al. (2007) recorded Stevia herbage yield of 0.98 t per hectare accounting a marginal reduction of 5.93 % in herbage yield compared to sole crops in open condition.

Reduction in growth of Valerian (Valeriana wallichii DC.) under artificial shade was reported by Singh et al. (2000). Similarly, Karikalan et al. (2002) and Gangadharan and Menon (2003) reported reduction in growth of medicinal plants grown under Kapok Ceiba pentandra (L.) Gaertn. Higher dry matter production in open fields than in intercropped situation due to greater availability of solar energy for photosynthesis was reported by Trang and Giddens (1980). Balasimha (1989) observed thin leaves with higher chlorophyll content in shade grown crops.

2.2. V Growth and yield of Patchouli (Pogostemon cablin Benth.) as intercrop

Possibility of growing Patchouli plant as an intercrop with Coconut, Papaya (Carica papaya Linn.), African oil palm (Elaeis guineensis Jacq.), Rubber (Hevea brasiliensis (Willd.) Muell.-Arg., Pine etc. was explored by various workers (Jimenez et al., 1990; Viswanathan et al., 1993 and Muniram et al., 1999). Some reports suggested that it grows well under shaded environment and yields higher herb and oil in tropical condition (Dorawamy, 1967 and Hussain et al., 1988). Muniram et al. (1999) at Lucknow reported that when Patchouli was intercropped with Papaya raised at 2m x 1 m spacing, herb yield increased by 90 %, oil yield by 76% and the quality of oil by 8-11% over its sole crop. They reported increase in Patchouli alcohol also in the intercropped situation than in sole Patchouli crop. Radhakrishnan et al.
(1991) reported significantly higher herbage yield of Patchouli (3578 kg/ha under 25% and 4243 kg/ha under 50% shade) than open condition (2027 kg/ha). They found the highest oil yield under 50% shade (172.82 kg/ha) followed by 25% shade (117.78 kg/ha) and the least under the open condition (75.82 kg/ha). The preference of Patchouli to partial shade conditions was also stated by Venugopal et al. (2005) who registered superior quality of oil and high percent of oil recovery (1.65% on dry weight basis) in Patchouli plants under shade cultivation as compared to open (0.87%) cultivation.

However, in Sirsi taluk of Uttara Kannada district, there was marginal reduction (-10.49%) in herbage yield of Patchouli when it was grown with Teak compared to sole crops (Sharanabasappa et al., 2007).

2.2. VI Growth and yield of Colocasia (*Colocasia esculenta* Schott.) as intercrop

As intercrop, growing of Colocasia under natural shade of Coconut, Khasi Pine, Som, Arecanut and Mango trees were reported by Dhyani and Chauhan (1989), Pamehgam et al. (2000), Bandyopadhyay et al. (2004) and Haque et al. (2004).

In Khasi hills of Meghalaya, Dhyani and Chauhan (1989) reported that Colocasia gave high yields in partial shade as compared to open condition and complete shade of *Pinus khasya*. Under shade, Colocasia had an increased stomatal density in both the upper and lower epidermis and this response of Colocasia was postulated as a possible manifestation of greater shade adaptation by the species (Onwueme & Johnston, 2000).

However, Bandyopadhyay et al. (2004) reported reduction in the LAI (leaf area index) of Colocasia due to longer LEI (leaf emergence interval) and shorter leaf duration along with reduction in corm yield by 8.2 % when grown as intercrop in young Arecanut plantation in Nadia, West Bengal.

In Bangladesh, under shade of juvenile (8-10 years old) Mango trees, Colocasia produced yield of 8.60 t/ha (Haque et al., 2004).
2.2. VII Growth and yield of Potato (Solanum tuberosum L.) as intercrop

Raising of Potato was reported to be profitable as intercrop with Coconut (Rethinam, 1989), Som (Pamehgam et al., 2000), Sugarcane (Hussain et al., 2003) and Maize (Singh et al., 2005).

On a well drained sandy loam soil in Bihar, tuber yield of Potato as intercrop in a Maize + Potato intercropping system increased significantly when the crops were fertilized adequately (Singh et al., 2005).

2.2. VIII Growth and yield of Onion (Allium cepa L.) as intercrop

Growing of Onion as intercrop with Sugarcane (Chatterjee et al., 1989 and Hussain et al., 2003), Mulberry (Gangwar & Thangavelu, 1991) and Litchi Litchi chinensis Sonn. (Attri et al., 2008) have been reported.

2.3 Land equivalent ratio in intercropping system

Evaluation of intercropping efficiency is done based on several indices. One of the most commonly used indices is land equivalent ratio (LER). Land equivalent ratio as an index of combined yield for evaluating the effectiveness of all forms of intercropping system was proposed by Willey and Osiru (1972). LER compares the biological efficacy of intercropping system to that of agricultural, sericultural and forest monocultures. It is used for determining whether or not it is more beneficial to associate trees with crops than to produce them separately. The LER corresponds to the required land for obtaining production equivalent to one hectare using intercropping system if trees and crops are produced separately. An LER greater than 1 therefore indicates that the intercropping system is more productive.

Higher LER, net return and benefit cost ratio values in intercropping systems compared to sole cropping indicating advantage of intercropping over sole crops were reported by many workers (Patra et al., 1999; Daniel et al., 2001; Polthanee et al., 2001; Padhi, 2002; Ayoola & Adeniyan, 2006 and Pathak & Singh, 2006).
In a Leek-Celery intercropping system, replacing half of the Celery plants by 11 Leek plants per sq. meter increased total biomass production by 61% with a LER of 1.56, compared with pure stand of Celery (Daniel et al., 2001). Polthanee et al., (2001) reported that Cassava-Legume intercropping systems usually increase the land use efficiency and economical return over sole Cassava. In a Cassava –Maize and Cassava –Melon (Citrus lanatus (Thumb) intercropping systems, intercropping had no significant effect on Cassava root yield but it reduced Maize and Melon seed yield compared to sole cropping. However, LER values were higher under intercropping than sole cropping as reported by Ayoola and Adeniyan (2006). In Uttarakhand, Urdbean (Vigna mungo (L.) Hepper) and Maize intercropping system was also found superior to sole cropping of both Urdbean and Maize in terms of LER as reported by Pathak & and Singh (2006). Graves et al. (2007) estimated LER of several dozens of intercropping system scenarios and found that LER of intercropping system was greater than 1 and could even reach 1.4. This means that 1 hectare under intercropping system produces as much as 1.4 hectares where trees and crops would be produced separately.

Nageswara Rao et al. (1990) opined that specific combinations of crops are necessary in intercropping system to maximize the LER. Khola et al. (1999) reported that biological sustainability of intercropping over sole cropping was indicated by higher LER values under different crop combinations. Kurian et al. (2003) reported that intercropping medicinal plants with tree components is an attractive option as that would increase land use efficiency and simultaneously improve the economic status of the farmers.

2.4 Profitability under intercropping system

Most of the intercropping systems were found to be highly remunerative over the sole cropping (Anonymous, 2003). On the other hand, greater yield stability in intercropping systems was claimed by various workers (Baker 1980; Rao & Willey, 1980; Rao & Morgado, 1984). The higher productivity of intercrop system compared to sole crops may be attributed to better light utilization by a crop canopy composed of plants with different foliage distribution. In a study of Maize and Pigeon pea (Cajanus cajan (L.) Millsp.), Sivakumar and Virmani (1984) found that dry
matter production per unit of photosynthetically active radiation (PAR) absorbed was higher in the mixture than in sole crops. According to Gill and Sharma (2005), intercropping increase the productivity and provide income stability under limited soil moisture conditions. An additional income of ₹ 3,000-4,000 per acre Mulberry was obtained in Tamil Nadu through intercropping of Onion, Tomato, Brinjal, Lady’s finger and Maize (Gangwar & Thangavelu, 1991). Chauhan (2000) reported higher net income from Poplar (Populus deltoides) with aromatic crops like lemongrass (Cymbopogon flexuosus) and Japanese mint (Mentha arvensis) than growing of sole Poplar or sole aromatic crops. According to Dhingra et al. (2002), ₹ 12,338 per acre may be earned from intercropping of Coriander (Coriandrum sativum L.) during winter with Mulberry. However, additional dose of fertilizer and FYM should be added to intercrop in addition to the recommended fertilizer applicable to Mulberry plants (Anonymous, 1995). With the same doses of fertilizers and FYM application resorted to sole crop of Mulberry, net additional income of ₹ 2,630 was obtained from Mulberry + Turmeric system than that of sole Mulberry in the same piece of land (Tikader, 1991).

Pamehgam et al. (2000) reported that intercropping of Colocasia in summer and Potato in winter during two years of gestation period of Som can generate an income of more than ₹ 6000/-per acre Som plantation without any adverse effect on Som growth. Later on, according to Hazarika et al. (2007), intercropping of Ginger, Turmeric, Colocasia and Chilli with Som are also economically viable and the practice can be adopted by the traditional Muga farmers of Assam to generate additional farm income.

In a multistorey cropping of Mango, combinations of four intercrops viz., Bay, Black pepper, Pineapple and Ginger gave 91-143 % more net returns over the monocrop (Awasthi & Saroj, 2004). In another study conducted by Haque et al. (2004) in Bangladesh, under shade of juvenile (8-10 years old) Mango trees, Ginger, Turmeric and Colocasia generated higher gross return, net return and benefit cost ratio compared with adult Mango trees. From a Coconut based farming system, Ginger can generate an additional net return of ₹ 88,950 per hectare (Anonymous, 2004).

Reddy and Biddappa (2000) reported that Coconut and Yam intercropping system gave higher net return (₹ 5,650/ha) than Coconut mono cropping.
(₹ 2,520/ha). According to Shanthamallaiah et al. (1982b), Mulberry as a mixed crop increased net income by ₹7,379/ha and doubled the employment potential. At Lucknow, Muniram et al. (1999) observed an increase in economic return by ₹25,000/ha/year from Patchouli intercropped with Papaya over sole crop of Papaya. Potato in winter and Colocasia in summer as intercrops with Som (3 m x 3m spacing) generated an additional income of ₹6,756 and ₹6,867 per acre as reported by Pamehgam et al. (2000) at Jorhat. In a Sugarcane + Potato – Sesame (Sesamum indicum L.) intercropping system, an additional income was 65.9% and 26.7% at Chuadanga and Jessore of Bangladesh respectively. Similarly, in a Sugarcane + Onion – Sesame intercropping system, additional income was 123.8% and 83.8% at Chuadanga and Jessore of Bangladesh respectively (Hussain et al., 2003).

2.5 Effect of intercropping on soil properties

Intercropping systems are agro ecosystems that address numerous environmental issues. Nutrient removal by crops grown either alone or in an intercropping system is primarily governed by genetic character of the variety, edaphic and prevailing environmental factors, suitability and availability of applied nutrient, water in root zone, and microbial population, etc. It is believed that component crops when raised alone exploit different soil layers and when grown in association exploit greater volume of soil. Such difference in rooting pattern could occur due to the tendency of roots to avoid their overlapping. The crop thus avoids the areas which have already been depleted by an associated crop. An evidence to support this hypothesis was that component crops having deep roots forced its roots even deeper by the presence of shallow rooting components (Lakhani, 1976).

Intercropping can contribute substantially to increasing the return of organic matter to the soil as a result of residues from aboveground intercrop biomass and in situ decomposition of intercrop roots. Bopaiah and Shetty (1991) reported higher microbial biomass, organic carbon (C), total nitrogen (N), phosphorus (P) and potash (K) in the root region soils of intercropping system than in the Coconut monocropping. Upadhyaya et al. (1994) reported an improvement in soil fertility of Orange (Citrus reticulata Balano.) orchards as a result of the recycling of nutrients through organic
matter applied in Ginger intercrop. Later on, some workers reported that intercropping of pulses enhance soil fertility and improve soil texture besides generating income to the farmers. Further, inter cultivation helps in better aeration, stimulation of plant growth and deep penetration of rain water for better retention of soil moisture (Yadav & Kumar, 1998). Price et al. (1999) also reported that organic matter from intercrops results in an increase in soil microbial biomass and earthworm populations contributing to the improvement of soil fertility. In Quebec, a greater diversity of microbial populations, especially those of Arbuscular mycorrhizae has been observed in the soil of an intercropping system of hybrid Poplar and Soybean in comparison with Soybean and Poplar monocultures (Chifflet et al., 2009).

Reddy and Biddappa (2000) mentioned that the average soil loss in Coconut based mixed cropping with Spices was much less (0.5 t/ha) than the normal rate of soil erosion (10-15 t/ha) in the Andaman and Nicobar islands. Intercropping of Mandarins helped in stabilizing the steep slopes of the Himalayan foothills of Sikkim besides providing food security and opportunities for cash flow to the farmers (Kesang Lachungpa, 1999).

Pathak (2004) reported that intercrop may capture a large portion of ET as transpiration than sole crops do. Increase in transpiration as a fraction of evapo-transpiration occurs because of expanded plant cover, which reduces soil evaporation.

Muga and Mulberry integrated cultivation also improved soil nutrient status at Jorhat, Assam over the initial status as well as over the parallel mono Som and mono Mulberry cultivation as reported by Phukan et al. (2008).

2. 6 Effect of intercropping on pest and disease management

Medicinal plants as intercrops in Arecanut gardens reduce the dependence on chemical pesticides and fungicides as they are more resistant to pests and diseases. Some workers investigated that intercropping has great impact on management of termites in agriculture and forest plantation. Sattar and Salihah (2001) suggested growing of Turmeric around the field of Sugarcane to repel the termites. The beneficial effect of intercropping Garlic in reducing termite population in agro
ecosystem of Sugarcane and bud damage of Sugarcane was reported by Ahmed et al. (2008).

The incidence of root rot of Cotton caused by Rhizoctonia solani and R. bataticola fungi is appreciably reduced by intercropping with Moth crop (*Phaseolus aconitifolia*) as reported by Raheja (1973). He reported that the moth crop lowers the soil temperature which is unfavourable for the parasitic activity of the fungi. In a Muga and Mulberry integrated culture, no cross infection of pests and diseases on the foliage as well as on the silkworms was recorded (Phukan et al., 2008).

2. 7 Effect of intercropping on weed management

The benefit of intercropping or mixed cropping in controlling weeds was reported by Yadav and Kumar (1998). He reported that inter cultivation in intercropping system helps in weed suppression.

Suresh et al. (2003) conducted a farmer participatory research in Dharampuri district, Tamilnadu on the effects of leguminous intercrops on suppression of weeds in Mulberry field and reported that legumes suppressed weed population significantly both by number and weight.

2. 8 Effect of intercropping on growth of silkworm

By feeding Mulberry leaves obtained from different intercropped (*viz.*, Cowpea, Green gram, Blackgram, Soybean and Groundnut) plots revealed non-significant difference in mature Mulberry worm weight and post cocoon parameters indicating to deleterious effect of intercrops on leaf quality (Shankar et al., 2000). Similarly, a study carried out at Dharwad on growth and cocoon yield of Mulberry as influenced by legume intercrops showed non-significant difference with respect to larval characters and significant increase in silk productivity and silk gland weight. Moreover, the incidence of flacherie, grasserie and muscardine diseases of Mulberry silkworm in intercropping treatments was less compared to sole Mulberry (Duragappa et al., 2005). No influence of intercrop on disease incidence in Mulberry was also reported by Sawalgi (2002).