



Evaluation of long term trends in apple cultivation and its productivity in Jammu and Kashmir from 1975 to 2015

Mohammad Shafi Bhat · Fayaz A. Lone · Mifta ul Shafiq · Javaid A. Rather

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Abstract Horticulture plays a pivotal role in the economy of Jammu and Kashmir. Owing to favourable agro-climatic conditions, temperate horticulture is fast expanding in the state which is characterised by the increasing dominance of apple cultivation. In the present study, an attempt has been made to evaluate the long term trends in the productivity and areal expansion of apple cultivation in the state. It has been observed that area under apple cultivation has witnessed a considerable increase (326%) from year the 1975–1976 to the year 2015–2016. This trend is translated in the compound growth rates of both area and yield which has witnessed an increase at the rate of 0.69 and 3.09 respectively. The decomposition model analysis predicted that apple production is mainly contributed by area effect (65.73) followed by interaction effect (23.71) and yield effect (10.55). The rapid increase in the area under apple cultivation can be attributed to higher profitability. Climate change has also played a role in encouraging the shift in land use pattern in the state. The yield of apple is showing clear signs of stagnation and is hovering between 9 and 10 MT/ha during the last four decades. Therefore, policy intervention by the government along with the up-gradation of pre and post-harvest technology is the

need of the hour to boost the productivity of this sector.

Keywords Apple · Horticulture · Jammu and Kashmir · Climate change · Productivity · Yield

Introduction

Agriculture plays a very prominent role for the economic development of J&K State. It contributes around 27% of the state's economy. Almost 70% of its population is dependent on agriculture and about 49% of the working class is engaged in it. During the last several years, diversification of Agriculture in State towards high-value commodities, i.e. fruits, vegetables and livestock products is taking place at a faster pace and is reflected in the high share of High-value Commodities (HVCs) in agricultural production in a number of districts.

Over the years, horticulture emerged as an important and growing sub-sector of agriculture, offering a wide range of choices to the farmers for crop diversification. It also provides ample opportunities for sustaining a large number of agro-industries which generates substantial employment opportunities. J&K State is well known for its horticultural produce both in India and abroad. The state offers good scope for cultivation of horticultural crops, covering a variety of temperate fruits like apple, pear, peach, plum, apricot,

M. S. Bhat (✉) · F. A. Lone · M. u. Shafiq · J. A. Rather
Department of Geography and Regional Development,
University of Kashmir, Srinagar 190006, India
e-mail: shafihabib@uok.edu.in

almond and cherry. Year after year, there is a significant increase in area and production under horticulture crops. There are around 7 lakh families comprising of about 33 lakh people who are directly or indirectly associated with horticulture. As a result, there is a perceptible change in the concept of horticulture development in the state. The area under Fruits in J&K State has increased from 85,508 hectares in 1975–1976 to 337,677 hectares in 2015–2016 and production has crossed 2,493,999 MTs in the same period.

Horticulture occupies a very important position in the predominantly agricultural economy of western Himalaya, among all the fruits grown in the Kashmir (Rasool et al. 2016). The Horticultural sector contributes immensely to strengthen the financial condition of Jammu and Kashmir. Horticulture is the mainstay of the economy in Kashmir with 2.3 million people associated with the sector and 237,000 hectares of land in the valley under fruit cultivation. This is a core sector of Jammu and Kashmir agriculture (Rajesheri and Ali 2016). Apple industry is one of the important sources of the economy and its Apple cultivation in the state is fast expanding because apple has a comparative advantage over the other crops that can be grown in hilly regions. J&K is a major apple producing state accounting for 67.7% of the total apple production in the country and the production per hectare is 10.0 metric tons, which is higher than the national average.

Although Apple was introduced by the British in the Kullu Valley of Himachal Pradesh in 1865, while as the Red Delicious cultivar was introduced Shimla Hills in 1917. The apple cultivar Ambri is considered to be indigenous to Kashmir and has been growing long before the western introduction of apple in the country. Although the entire Indian Apple industry is centered in the three states of J&K, Himachal Pradesh and Uttarakhand, the bulk of the National production comes from Jammu and Kashmir.

To the best of our knowledge, no such study has been done till date which talks about the trends in long term production, productivity and yield of Apple crop in Jammu and Kashmir state. Keeping the above mentioned facts in consideration, this study uses empirical data and will be first of its kind dealing with multiple facets concerning apple crop in Jammu and Kashmir. This work was done with two primary objectives of evaluating the long term trends in area

and productivity of apple in Jammu and Kashmir and to evaluate the trends in yield and compare them with national and global yield scenarios. The research uses several statistical measures to analyse the trends in production, productivity and yield over the entire state of Jammu and Kashmir. Furthermore, this paper also attempts to analyse the reasons for growth in apple cultivation with problems plaguing this important sector of the economy.

Literature review

Jammu and Kashmir has immense scope for horticulture development owing to its topography, climate and enormous diversity of agro-climatic niches in J&K (Swarup and Sikka 1987). Masoodi (2003) in his study has shown that J&K has the highest average yield and accounts for approximately 2/3 of total apple production of India. In their study revealed that the apple cultivation in Jammu and Kashmir is an old age activity and around 200 varieties of apple were used to be cultivated in the state. Kashmir apple has lived up to its reputation for being one of the choicest fruits in India. Mir (2014). In his study concluded that on account of higher returns and ability to stand transportation stress, amongst all other fruit and field crops apple has found a better reception with the growers. The apple crop involving around half a million households dominates the horticultural industry and has an important role in the economic scenario of the state (Malik and Choure 2014).

Ahmed (2013) has revealed a significant increasing trend in the area under apple cultivation. Due to its higher returns and ability to stand transportation stress, amongst all fruit and field crops, apple has found a better reception with the growers. The apple crop involving around half a million households dominates the horticultural industry and as an important role in the economic scenario of the state (Malik and Choure 2014). Apple cultivation is highly profitable economic activity in the state, owing to the high quality of fruit. It is a farm-based labour intensive and commercially attractive economic activity. The income per acre is much higher than any other horticulture crop, if it is done in a systematic way. It has been found that the farmers face numerous problems like marketing, storage facilities, good quality pesticides, irrigation etc. which affects the overall productivity of the

sector. It has been suggested that if these impediments are removed, productivity could be enhanced just like in China and other European countries. (Bhat and Choure 2014).

The horticultural sector contributes around 5000 crores to the annual income of the state of Jammu and Kashmir. Among the horticultural crops in the state apple occupies the predominant position constituting around 45% of the total area under fruit crops. This sector contributes significantly to the economic and ecological development, employment generation, export and nutritional requirement of the people of the state. Apples are most widely planted and are commercially the most important fruit crop. The cultivation of apple crop in Jammu and Kashmir shows particular interest for a number of reasons. In terms of both area and production, apple is very a beneficial fruit crop. Apple is an extremely important source of nutritive diet and provides a major source of income and employment in Jammu and Kashmir. The horticulture sector in the valley of Kashmir has lost its glory and pride. Kashmir was once home to high quality fruit and the industry was booming, helping not only in the employment generation but also in driving the economy (Zulfiqar 2015). Rajesheri and Ali (2016), Observed that horticulture occupies a very important position in the predominantly agricultural economy of western Himalaya, among all the fruits grown in the Kashmir. The horticultural sector contributes immensely to strengthen the financial condition of Jammu and Kashmir. Horticulture is the mainstay of the economy in Kashmir with 2.3 million people associated with the sector and 237,000 hectares of land in the valley under fruit cultivation. This is a core sector of Jammu and Kashmir agriculture.

Bhat (2014), In his study, revealed that as a dominant crop of the valley “Apple” proudly represents the fruit industry of Kashmir, representing 98% of the total fruit production. Apple industry is the backbone of the economy of Kashmir valley particular in Shopian district. Due to its good backward and forward linkages, it provides employment to about 60% of the population and is the main source of livelihood of many households. But there was no significant increase in the production of this industry during the last few years due to various reasons such as lack of cold storage, a large chain of commission agents from the grower to consumers in the Kashmir valley as a whole.

Study area

The state of Jammu and Kashmir is located in the Northwestern folds of Himalayas in the Indian sub-continent (Fig. 1) covering a total geographical area of 222,236 km² (Hussain 1987). Due to favourable agro-climatic conditions (Shafiq et al. 2019), there is a tremendous scope and the state has emerged as a hub of temperate horticulture in India as it contributes 75% to the national production. Being a dominant horticultural crop of the valley Apple proudly represents the fruit industry of Kashmir, representing 98% of the total fruit production. Apple industry is the backbone of the economy of the state. Due to its good backward and forward linkages, it provides employment to about 60% of the population and is the main source of livelihood of many households. Apple cultivation in Jammu and Kashmir is an old age activity and around 200 varieties of apple were used to be cultivated in the state. Kashmir apple has lived up to its reputation for being one of the choicest fruits in India.

Database and methodology

The present study is based on the data collected from several field agencies, on spot surveys and government departments for area and production of apple from 1975 to 2015. To assess the change, the secondary data was collected from the Directorate of Economics and statistics Govt. of Jammu and Kashmir, Directorate of Horticulture, Kashmir and several reports of Food and Agriculture Organisation. A host of statistical techniques particularly linear regression test were done on time series data of area and production to measure the level of trend and magnitude of change in the data series.

Furthermore, to assess the magnitude of change in the perception of apple cultivators, a set of 500 scheduled questioners were prepared in consultation with experts ranging from filed of climate sciences, agriculture sciences and social scientists. The response of local people was recorded in these questioners to frame the perception at the grass root level. Care was taken so that the respondents were of different categories mostly based on the size of land holding which was categorised into three categories viz. Small farmers (< 1 ha), Medium farmers (1–3 ha) and large farmers (> 3 ha).

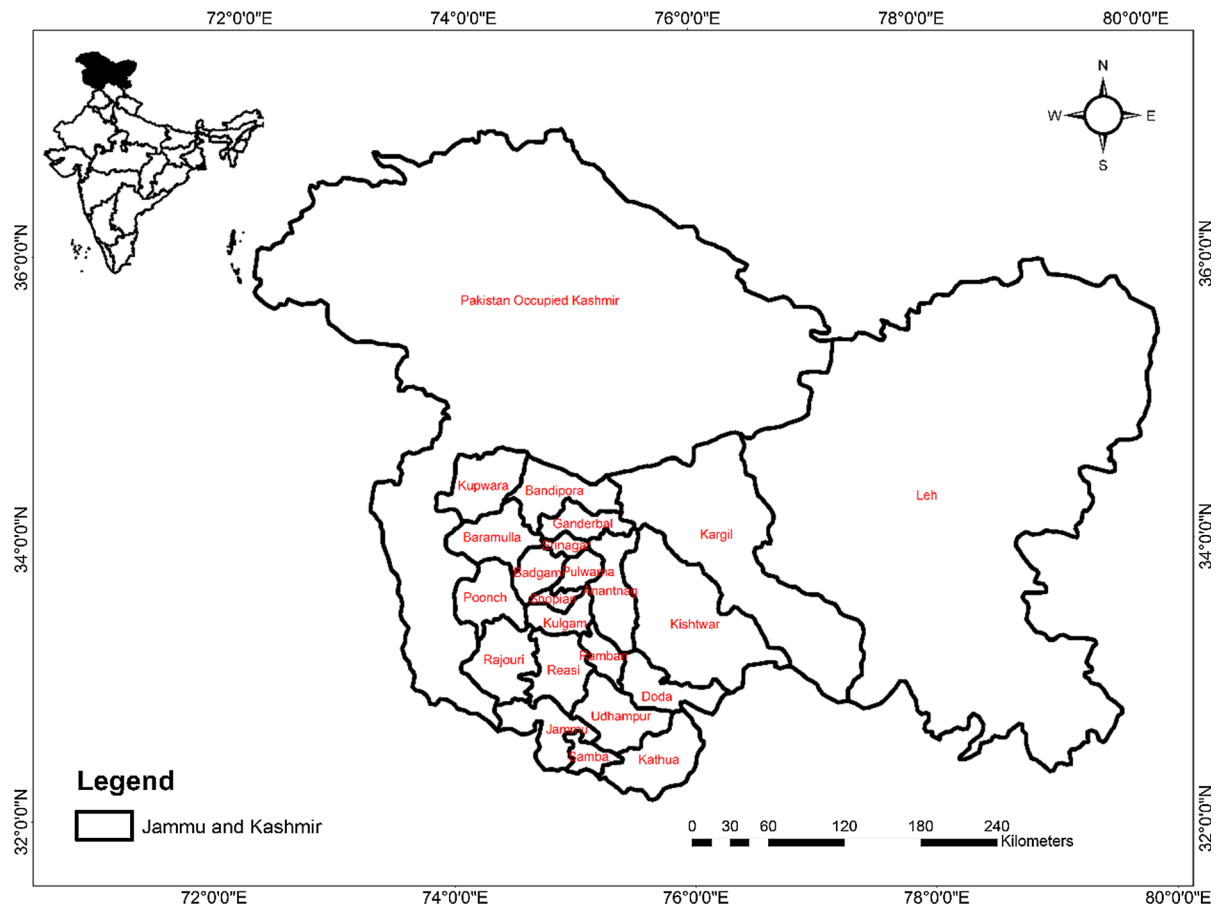


Fig. 1 Location map of the study area showing districts in Jammu and Kashmir

Compound growth rate (CGR)

The compound growth rates for the study area pertaining to area, productivity and yield of apple were computed by fitting the power function to the respective figures for the period of 1975–1976 to 2015–2016. The ordinary least square method was used to fit the power function of the following form $Y = ab^t$. It was converted into log linear function with the help of logarithmic transformation as under:

$$\log Y = \log a + t \log b$$

where Y = Dependent variable (Area, production and productivity), t = Independent variable (time in a year).

Compound growth rates (CGRs) were calculated by using the following formula adopted by Green.

$$\text{CGR} = (\text{Antilog } b - 1) \times 100$$

Decomposition component analysis

Decomposition component analysis model proposed by Minhas and Vidhyanathan (1965) is used to study the relative effect of area and productivity on the change in production. Narula and vidyasagar (1973), and Sharma modified the model to a large extent and it was subsequently used by various researchers to study the performance of crops at state level (Singh and Siddodia 1989; Bastine and Palanisami 1994; Bhatnagar and Nandal 1994; Mundinamami et al. 1995; Gupta and Saraswat 1997; Siju and Kombairaju 2001). The change in production in a given period of time is the outcome of change in area, productivity and their resultant interaction.

Thus, the total change in production due to change in yield and area can be decomposed into three effects viz. Yield effect, area effect and the interaction effect.

$$\Delta P = AB * \Delta Y + YB * \Delta A + \Delta A * \Delta Y$$

Change in Production = Yield effect + Area effect + Interaction effect. Where,

$$\Delta P = PC - PB$$

$$\Delta Y = YC - YB$$

$$\Delta A = AC - AB$$

AB, PB and YB are the area, production and yield of Apple for the base year. AC, PC and YC are the area, production and yield of Apple for the current year.

Results

Trends in area

Apple cultivation has registered a phenomenal growth during the last 45 years in the State of Jammu and Kashmir located in the North-western folds of Himalayas. Earlier only a few districts like Baramullah and Shopian were having substantial acreage under apple cultivation. With the passage of time, it swiftly spread across all the ten districts of Kashmir Valley and also two districts of Leh and Kargil owing to large scale changes in the land use pattern in the last two decades. The area under apple cultivation in J & K has increased from 47,342 hectares in 1975 to 163,432 hectares in 2015. Current land use statistics (2015) reveal that apple is the dominant fruit-crop covering approximately 47.9% of the area under horticulture in the state followed by Walnut with 26.5% and pear with 4% crops respectively in the valley of Kashmir. While having a look at the total area under fresh fruit, apple has established its dominance in the state covering 67% of the total area (Fig. 2). The perusal of Table 1 shows that area under apple cultivation has seen an annual compound growth rate of 3.09 from 1974–1975 to 2014–2015 showing tremendous growth of the area (Fig. 3).

Careful analysis of data from Fig. 4 reveals that although expansion in the area under the apple cultivation continued throughout the study period, its pace significantly increased after year 2000 onwards. In the last quarter of twentieth century there prevailed

a study but modest increasing trend in the area under apple cultivation, while as a robust increasing trend was witnessed by the end of twentieth century (Fig. 4). Present study reveals that from 2000 to 2015 there was approximately 100% increase in the area under apple cultivation on account of various geo-environmental and socio-economic factors. In some districts like Shopian there is almost total conversion of agricultural land to horticulture mainly dominated by the apple cultivation. Other districts such as Pulwama, kulgam, Anantnag, Baramullah, and Kupwara have also witnessed significant increase in the area under apple cultivation during the last two decades.

Trends in apple production

The perusal of Table 1 reveals that ACGR of apple production stood at 3.7 from 1974–1975 to 2014–2015 showing considerable growth in apple production in Jammu and Kashmir. The production was 348,011 MT in 1975 to 1,170,306 MT in year 2015 which translates into an increase of 290% (Fig. 5). However, this growth in production is largely attributed to the rapid expansion in the area under apple cultivation, rather than improved productivity of apple farms. Baramulla district is the largest producer followed by Shopian, Kupwara and Kulgam districts. Although overall production has increased owing to expansion in area under cultivation, the yield per hectare could not be increased to the desired levels due to various agronomic, technological and socio economic factors.

Although on account of favourable geo-environmental conditions like moderate temperature regime and adequate chilling hours during the winter season, apple yield in the state of Jammu and Kashmir are higher than Himachal Pradesh and Uttarakhand which are the other important apple producers in the country. However, there are clear signs of stagnation in the apple yield in J & K as it has been hovering around 10 MT/Hectare from last 20 years and on this front appreciable progress has not been achieved. Figure 6 clearly reflects the scenario in which apple yields appear to be almost stagnant. Yields registered a marginal increase from 2000 to 2010 and subsequently dipping again below 10 MT/Hectare mark in 2015 on account of unfavourable climatic fluctuations (Shafiq et al. 2018) and the widespread unseasonal flooding of 2014 which adversely affected the production. This

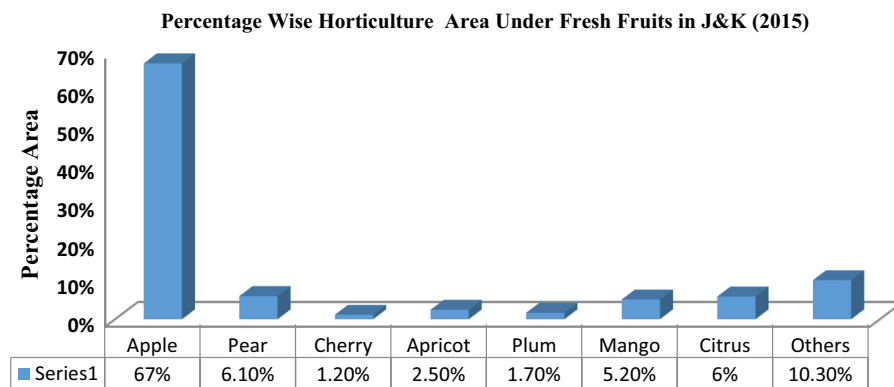


Fig. 2 Percentage wise Horticulture area under fresh fruits in Jammu and Kashmir (2015)

Table 1 Annual compound growth rate (ACGR) for apple with respect to area, production and yield from 1974/1975 to 2015/2016

Variable	CAGR
Area	3.09
Production	3.77
Yield	0.65

was substantiated by low ACGR value of 0.65 for the studied period.

Decomposition analysis

The total change in apple production can be decomposed into three components viz., yield effect, area effect and the interaction effect between the area and the yield in a particular region. The decomposition

analysis of the apple production in the study area has been presented in the Table 2. The perusal of the table reveals that the increase in the production of the apple from 3.4 to 11.7 lakh MT is mainly due to the increase in the area from 47 ‘000 ha to 1.67 lakh ha having around 65.73% contribution to the total production of apple. The stagnation in the yield as discussed above is clearly reflected in the model showing that yield has contributed only 10.5% to the overall production of apple in the study area. The yield of apple in the study area has been stagnant at 10 MT/ha from 1975 to 2015. The combined effect of the interaction between the area and yield has contributed around 23.7% to the overall production of apple in the study area. The results clearly indicate that increase in apple area is driving force behind the increase in production and not the yield.

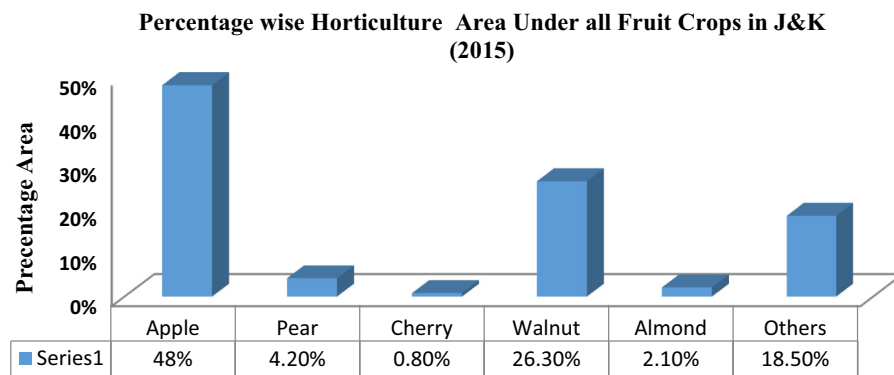


Fig. 3 Percentage wise horticulture area under all fruit crops in J&K (2015)

Fig. 4 Linear trend in long term area under apple cultivation in Jammu and Kashmir from 1975 to 2015 in hectares

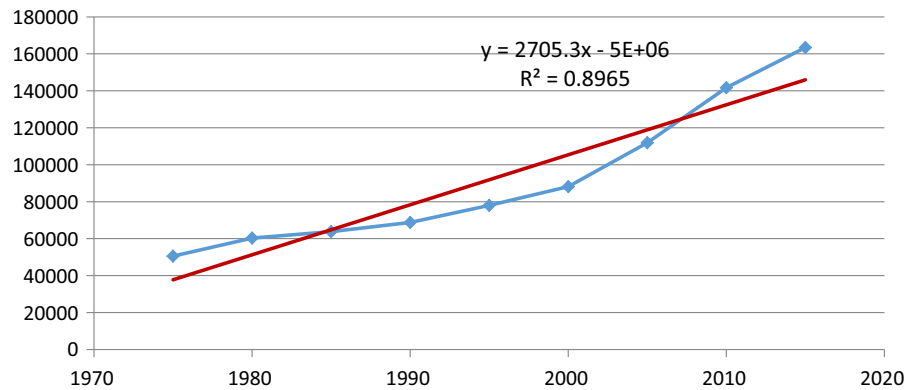


Fig. 5 Annual apple production from 1975 to 2015 in Jammu and Kashmir in Metric Tonnes (MT)

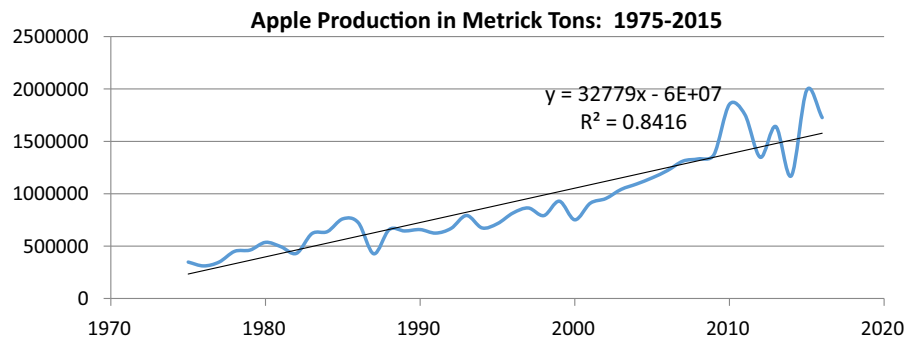
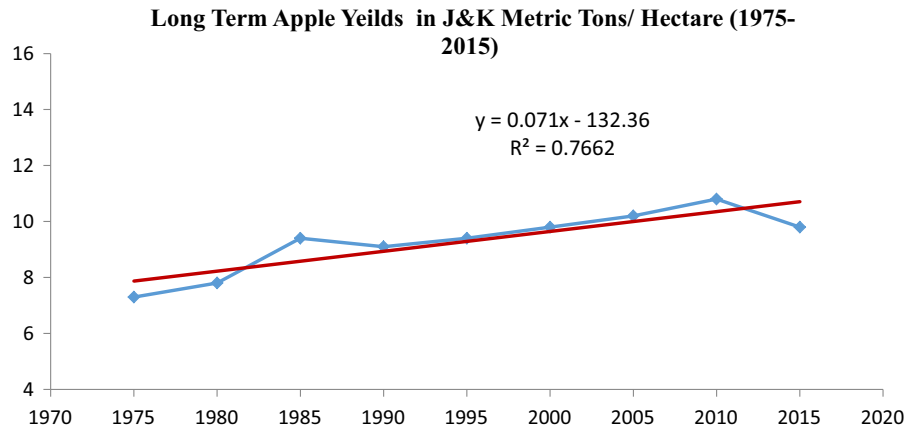


Fig. 6 Linear trend in the yield of apple in Jammu and Kashmir from 1975 to 2015 in MT/ha



Perception of apple cultivators

Present study analysed the causes of large scale conversion of agriculture land to horticulture in recent decades with the help of a primary survey across the study region. From the data it became evident that economic reasons or higher returns of apple per unit land are the main drivers of land use change. Around 63% of the respondents confirmed that favourable

cost–benefit ratio in apple prompted them to convert to apple cultivation. Almost 27% of the respondents reported that climate change has forced them to convert from agriculture to horticulture on account of reduced availability of water for irrigation especially for water intensive crops like paddy in the Kandi (rain-fed) and foot hill regions of the study area. This statement is validated and confirmed by the data which clearly indicates a steep increase in land conversion to

Table 2 Decomposition analysis model for apple from 1975 to 2015 in the study area

Period 1974–1975 to 2015–2016					
Variable	Base triennium	Ending triennium	Total value	% Contribution to production	
Area (ha)	50,114	162,725.33	Area effect	828,819.41	65.73
Production (Mts)	370,038.67	1,628,451.33	Yield effect	133,071.14	10.55
Yield (Mts/Ha)	7.36	10.01	Interaction effect	299,024.60	23.71
				100%	

horticulture after three successive drought years in 1997, 1998, and 1999. Nearly 10% of the respondents considered other socio-economic, agronomic and technological factors responsible for the conversion towards apple cultivation which is indicated by (Fig. 7).

The comparative analysis of production figures and productivity trends across the globe reveal that the apple yields in the leading global apple producing countries are 4–5 times higher than J&K, ranging between 40 and 50 MT/Hectare. In certain countries apple yield of 70–80 MT/Hectare has also been registered, which is evident from Fig. 8. Furthermore, the statistics of FAO reveal that at the global level the area under apple cultivation is reducing with the passage of time, but due to improvement in productivity or apple yields overall global production figure are marginally improving.

Although the Geo-environmental conditions for the apple cultivation in Kashmir Valley are somewhat similar to the European Union, the low yields in J&K can be attributed to the lack of awareness among the growers, unscientific agricultural practices, lack of

pre-harvest and post-harvest support system and lack of modernisation and innovation in horticulture. If these bottle necks are removed there is great possibility that yield and production can be easily increased three fold with moderate scientific intervention.

Discussion and conclusion

Apple cultivation in the state of Jammu and Kashmir has registered a decent growth both in terms of areal expansion and overall production during the last 45 years. However, it has been revealed by the present study that the conversion from agriculture to horticulture especially apple cultivation increased drastically by the end of the twentieth century as the area under apple cultivation doubled from 2000 to 2015. Figure 9 presents some of the snapshots taken from apple orchards in the study area showing flowering in the apple trees to the harvesting of the fruits and conversion of agriculture to horticultural land. The empirical data reveals, that this rapid conversion was largely driven by the economic considerations on

Farmers Perception Regarding the Causes of Land Conversion to Apple Cultivation In Jammu & Kashmir

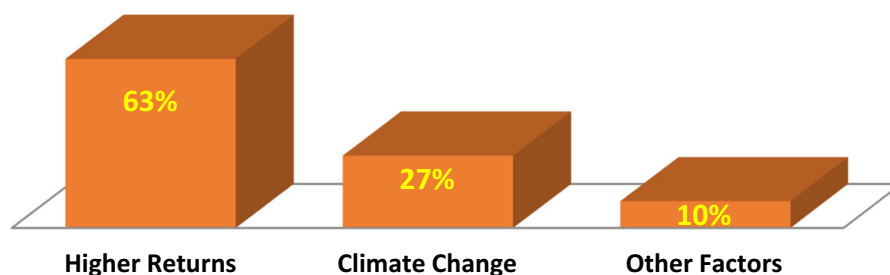
**Fig. 7** Bar graph showing the response of apple cultivators towards conversion to apple cultivation in Jammu and Kashmir

Fig. 8 Global scenario in apple productivity (MT/ha) 2010-FAO

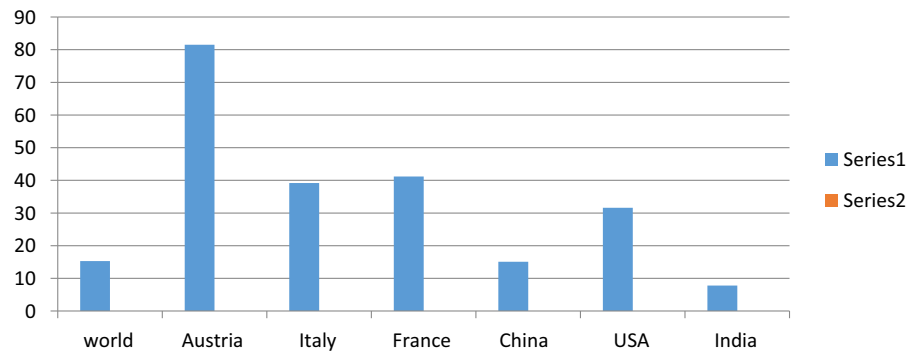


Fig. 9 Apple crop in study area showing flowering in apple trees, to harvesting and packing of apple and conversion of agriculture to horticulture land

account of favourable cost–benefit ratio of apple as compared to other crops, especially cereals. Furthermore, global warming and resultant change in climatic and hydrological regimes in the study area also encouraged the apple cultivation on account of its limited irrigational requirements. Other social and technological factors also contributed positively in the areal expansion of apple cultivation in J&K, as the new generation of farmers preferred horticulture over agriculture due to various operational as well as economic reasons. This period has witnessed the dominance of apple in horticulture occupying 48% of

the area under horticulture and contributing about 79% (2015–2016) of the total fruit production. The ACGR for apple hovered around 3% for area and production while in yield it was 0.65% from 1975 to 2015. The main finding of the study is the stagnation of the apple yield which is hovering around 9–10 MT/ha from last three decades which is indicative of the fact that appreciable progress in this regard has not been achieved. The decomposition analysis of the data revealed that area contributed around 65% to the total production of the apple crop with yield again showing a lower contribution of around 10%. The dismal

performance on account of yield can be attributed to the lack of awareness among growers, lack of training, mismanagement, Small land holding size, lack of adequate pre-harvest and post-harvest support system. By removing these impediments along with the adoption of modern scientific agronomic practices and innovative methods of modern horticulture, the yields can be improved 200–300% which will propel India among the top three producers at a global level.

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