

Present status, scope and future needs for mechanization of apple cultivation in mountains of Himachal Pradesh, India

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Abstract: A study was conducted to find out the present status and level of mechanization in different operations as carried out in apple cultivation. It was observed that most of these operations are performed manually by hand using traditional tools. Land preparation with spade (0.002 ha/h), pit digging with spade (3 to 4 pits/day of size 1x1x1 m), basin preparation with spade (2-4 basin/h), pruning by secateurs/pruner (1-2 plants/h) and harvesting by hand (12-15 kg h-1person-1) resulted in very low efficiency thus increase the cost of operation and drudgery and ultimately reduces the net returns to the growers. The bottlenecks in mechanization are due to undulating topography, small and scattered land holdings, lack of approach roads and lack of awareness among the farmers. In spite of these, there is a tremendous scope to mechanize various practices in apple cultivation in hills of Himachal Pradesh through improved and suitable mechanization technology so that the apple growers may be benefited.

Keywords: Apple cultivation, mountains, mechanization status

Citation: Singh, S., and D. K. Vatsa. 2015. Present status, scope and future needs for mechanization of apple cultivation in mountains of Himachal Pradesh, India. *Agric Eng Int: CIGR Journal*, 17(4):109-114.

1 Introduction

Himachal Pradesh is the hilly state of India which is located on a sloping terrain of the great Himalayas, with snow clad mountains, rolling hills and valleys. The state is situated between 30.3-33.3° North Latitude and 75.3-79.0° East Longitude. It is broadly classified into four agro-climatic zones viz. sub-montane low hills sub-tropic zones (365-650 m above m.s.l.), mid-hills sub-montane zone (651-1800m above m.s.l.), high hill temperate wet zone (1801-2200m above m.s.l.) and high hill temperate dry zone (>2200m above m.s.l.). Each agro-climatic zone can be further divided into various micro-agro-climatic zones due to great variation in slope, topography, soil and water availability. Numerous micro-agro-climatic zones provide favorable environment for raising almost all type of agricultural and horticultural

crops. Himachal Pradesh is called the Apple state of the country and is also known as the fruit bowl of the nation. Himachal Pradesh is at second largest apple producing states in the country and is the main fruit crop of the state. It is grown in nine out of the twelve districts. The area under apple cultivation in Himachal Pradesh has increased from 3025 ha in 1960-61 to 1.06 lakh ha in 2012-13 which constitutes more than 49% of the total area under fruit and 74% of total fruits production in the State (Anon. 2012-13). The apple industry of the state is making a significant contribution of about Rs. 3600 crores annually to the state economy. Although the area and production of Apple had registered manifold increase, yet the production fluctuates year to year and productivity remains low as compared to the advanced countries. The productivity of apple ranges from 6 to 11.5 MT per hectare in Himachal Pradesh in comparison to 35 to 40 MT in advanced countries. Low apple productivity is due to innate constraints such as rough weather, undulating topography, small and scattered land holdings and extrinsic factors like rain fed farming, weather sensitive

Received date: 2015-07-21

Accepted date: 2015-09-20

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varieties, inadequate pollinizer ratio, low mechanization and conventional orchard management technologies. To produce quality apple that meets the international standards is another challenge for survival of the apple industry of the state.

Agricultural mechanization technology plays a key role in improving agricultural production in developing counties, and should be considered as an essential input to agriculture (Rasouli et al., 2009). Proper use of mechanized inputs into agriculture has a direct and significant effect on production, productivity and profitability on agriculture farms, along with labour productivity and quality of life of people engaged in agriculture (Bishop, 1997; Clarke, 2000). Empirical evidence confirms that there is a strong correlation between farm mechanization and agricultural productivity. States with a greater availability of farm power show higher productivity as compared to others (Singh et. al., 2011). So, apple being a very important horticultural crop for the state economy, the study was conducted with following objectives:

- To critically study the various cultural practices in apple cultivation.
- To study tools and equipment used for various operations with their power source.
- To suggest future strategies for improving mechanization level in apple cultivation.

2 Materials and methods

Data and information on various operations as performed in apple cultivation was collected physically by visiting the apple orchards in different tehsils of Kullu district of Himachal Pradesh. This district is situated between 31.52-31.58⁰ North Latitude and 76.13-76.44⁰ East Longitude. The elevation of the district range between 1500 to 4800 meter above mean sea level and geographical area is 5,503 km² (Anonymous 2012-13). Kullu district has a unique geography with mountainous terrains with about 90% of its population living in village situated in far-flung and inaccessible areas. Natural

calamities, like cloud bursts, flash floods, heavy rains, earthquake, snowfall, hail storms, drought and accidents etc. cause a lot of misery to the people. The annual rainfall was recorded 1351.1 mm during the year 2012. The information on tools and equipment used, power source, capacity, problem and future needs for various operations was also collected from the farmers. The data were used to draw some meaning conclusions.

3 Results and discussions

3.1 Apple Cultivation Practices and Level of Mechanization

Apple is temperate fruit which require cool climate for their proper growth and development. The area and production of apple crop in Kullu district was about 24% and 21%, respectively of the total area and production in the State which was second highest among all districts of the State. Various farm operations are being performed for apple cultivation. The description of various operations performed in apple cultivation:

a. Field preparation

Field preparation for nursery raising and planting is very important aspects for growing apple orchards. Apple plant can grow on level grounds as well as considerably steep slope. For growing one hectare of orchard, 400-2500 plants are required and for that 0.001-0.01 ha area is required for raising nursery. Presently this operation was performed manually with the help of spade and kudali having field capacity of 0.002 ha/h. The time and cost required was 500 man-h/ha and 10,000/- INR. Thus, it was observed as very time consuming and drudgery oriented operation performed in hills.

b. Budding & grafting

Apple is mainly propagated by budding and grafting. The rootstocks are raised from the seeds of crab apple or commercial cultivars. For raising seedling plants, the seeds are stratified in moist sand either in open or in refrigerator at a temperature of 4⁰C-7⁰C for 60-90 days. The seeds after stratification are sown at a distance of 0.07-0.1 m in rows spaced out at 0.3 m. After every four

rows, 0.3-0.4 m space is left to facilitate working in the field. After one year, the suitable seedlings are used for grafting/budding. The clonal rootstocks are propagated by mound or stool layering. The graft union should be 0.2-0.3 m above ground level. The grafted plants are ready for planting in about one year. The budding/grafting was done with commercially available knife which consumes more number of labors. The capacity of this knife was 300-350 cuts/day/person.

c. Pit digging and planting

A pit of 1mx1mx1m is required to plant the apple at the plant spacing of 3.0 to 7.5 m in a soil of uniform texture. Where sub soil is compact or having stony stratum digging of large and deeper pit is justified. Pit digging was carried out manually with the help of spade which is costly and labour intensive operation. For digging 3-4 pits of size 1m³, one man is required per day depending on the soil conditions. For one hectare orchard, about 100-625 man-days were required for pit digging. The cost of this operation was observed about 20,000-1,25,000/- INR. The planting of apple was also done manually which consume a lot of labor that ultimately increased the cost of operation.

d. Basin Preparation

The newly planted plant needs regular care till its root system starts functioning and shoots have started vegetative growth. Immediately, after planting its basin has to be prepared. While preparing basin care should be taken that soil is raised around the stem of the tree so that it does not come in direct contact with water. Basin preparation up to depth of 0.10-0.15 m is recommended otherwise roots may damage. The basin preparation was carried out manually with spade and about 2-4 basin/h/person was prepared depending on the soil and plant canopy. The cost of operation was observed 6000-16,000/- INR/ha.

e. Fertilizer application

After basin preparation, farmers apply fertilizer manually then mixing with the help of spade. This was also a labor consuming operation. The capacity of the

fertilizer application and mixing with spade was observed 3-4 plants/h and cost involved was 10,000-16,000 INR/ha.

f. Plant protection measures

Apple plants needs regular spraying (at least 10-12 spray per season) to control the insects, pests and weeds which were carried out with hand and foot sprayer by most of the farmers. The capacity of these sprayers ranges between 0.8-1.5 ha/day.

g. Harvesting/ plucking

The plucking of apple is a very skill oriented operation and carried out manually by climbing on tree as well as using ladder which requires lot of labor and is very costly. Person tied/hanged the basket on the tree to put harvested apples and after filling, it was rolled down on the ground with the help of rope to get unfilled in the kilta (Figure 1). During peak season, shortage of labour was also observed. The capacity of the apple harvesting manually by a person was observed 12-15 kg/h.



Figure 1 Apple plucking in operation

h. Bird control

A number of birds feed on the apple fruit and thus damage it. These include magpies, robins, blackbirds, crows, parakeets, etc. Some of the practices/devices like crackers or whistler shot-guns, shells, fire crackers, netting the fruit trees, hanging the yellow plastic flags, black thread etc. was used by the growers for scaring the birds. But these are not very effective as well as costly. Farmers were also using anti-hail nets which also protect from the birds (Figure 2).



Figure 2 Anti-hail nets used on the apple plants



Figure 4 Kilta used for apple transportation

i. Training and pruning

This is the most important operation in apple cultivation. The main purpose of pruning is to develop a proper shape or form and regulate the bearing habit and quality of fruit with the minimum possible interference with the natural growth habit of the variety. The tools used for this purpose were secateurs, knives, pruners and saws (Figure 3). Sometimes lopping shears with long handles were also used for high trees. Good tools are as important as the skill of the pruner. Only a sharp blade can give a good cut. The average capacity of a person for pruning was 1-2 plants/h (full bearing plants).



Figure 3 Pruning of apple tree

j. Fruits handling/ transportation

Fruit transportation from orchards to the packaging store is mainly done manually in kilta on back of the person (Figure 4). The capacity of the kilta was 25-30 kg. So, one person can carry 25-30 kg apple in kilta and time required depends on the distance from orchard to the store or nearby road.

Many apple orchards are located on the higher peaks of mountains having no approach roads. For such orchards, mostly conventional rope ways (Figure 5) are being used by the farmers for transportation of fruits/material from orchards to nearby roads and then from there it is transported to the packaging store either in kilta or on horses.



Figure 5 Rope ways used for material handling

k. Grading and packaging

Apple being perishable needs quality packing and sensitivity while handling. In Himachal Pradesh apple sorting, grading and packing are being done manually (Singh et al., 2004) because the growers having small land holdings could not afford farm based mechanical processing line.

3.2 Future need for apple mechanization

Most of the operations for raising apple crop in mountains of Himachal Pradesh are performed manually with traditional tools having very low efficiency and higher drudgery, which need to be mechanized so that farmers of the state may be benefited and pay more

attention on these crops. The following are the time and labour intensive operations that can be mechanized by introduction of improved tools and equipment.

a. Field preparation

The traditional system of field preparation can be mechanized by introduction of suitable light-weight power source i.e. power tiller which can be operated easily in terraces (Figure 6). Different firms are manufacturing power tillers in India. The power tillers can be used for seed-bed preparation resulting in timeliness of operation (about 0.05 ha/h) with high efficiency as compared to manual and bullock system (Singh et al., 2007).



Figure 6 Power tiller for field preparation

b. Budding and grafting

The conventional budding and grafting knife resulted in 300-350 cuts/day/person hence consumes more number of labour. Thus, there is a need to introduce special devices/tools for grafting/budding for different types of shapes and cut and blades should provide a sharp cut.

c. Pit digging for planting

This operation needs to be mechanized with some mechanical diggers, tractor/power tiller operated post-hole digger as commercially available in the market having capacity about 30-40 pits/h because pit digging manually with spade consume lot of energy, time and is drudgery. Self-propelled post-hole digger can be used for pit digging.

d. Basin preparation and fertilizer application

At the peak time of basin preparation and fertilizer application, shortage of labour was observed to do the job

manually with spade. This operation could be mechanized by introduction of suitable light weight power tillers thus can save lot of time and drudgery. The time required for basin preparation by manual system was about 4 times the time required with power tiller system (Narang and Tiwari, 2005).

e. Plant protection measures

Mechanical power sprayer and aero-blast sprayer could be used to save the time and for better efficiency. Commercially available self propelled high clearance sprayer having capacity 0.5-1.0 ha/h could be used in apple orchards.

f. Harvesting/ plucking

As harvesting is being done manually, during peak season shortage of labour is also observed. Thus, there is need to introduce suitable harvesting/plucking devices and improved ladder which could save labour and time.

g. Bird control

Some electronic devices and chemical repellents could be used for scaring and controlling the birds to save the fruits from damage. Farmers are also using anti-hail nets which also protect from the birds.

h. Training and pruning

This operation needs improved secateurs and pruners which have sharp cuts. Best secateurs are one with a moving hold for the fingers. It causes the least discomfort while pruning. Long arm pruners or pole pruners are also used for pruning branches at the top of the tree while standing on the ground. Pole pruners are not available in India.

i. Fruits handling/ transportation

A person has to walk a long distance by carrying kilta containing 25-30 kg apples on the back from orchards or road sides to the packaging storage. So, some design refinement is required in kilta for easy transportation of fruits and other materials. There is also need of design refinement in conventional rope ways for safety purpose and improving efficiency. Many parts such as breaking system, trolley, trolley stopper, pulley needs refinement in rope ways used by the farmers.

j. Grading and packaging

Top quality grade of apples fetch better price to the farmers. Apple/fruit grader developed by GBPUAT, Pantnagar; CIPHET, Ludhiana and CIAE, Bhopal having capacity 10-15 q/h could be used at apple collection centres for mechanical grading of apple quickly. Sophisticated high speed computerized machines are also available for grading and sorting of apples but these are costly at farmers level. In HP, the government set the standards for apple packaging which involves use of inner and outer boxes made of reusable corrugated cardboards. These boxes have a capacity of 20 kg and have ventilation holes, cushioning trays to separate different layers of apples. These boxes are further marked for variety, packing date, geographical area, trademark of producer and weight.

3.3 Problems of farm mechanization in mountains

India has so far missed the opportunity of creating a strong Mountain/ Hill Agricultural research, education and extension system. The universities and other institutions located in the mountain have not been able to acquire the necessary Hill Perspective in the mandate and functioning. Focus on developing professional capacities for hill oriented R&E probably never received the necessary attention. Lack of understanding of the special needs of mountain environments is the other factor influencing the farm economics. The other factors which are influencing the pace of farm mechanization in Himachal Pradesh listed below:

- Undulating topography.
- Small sized and scattered land holdings.
- Poor financial position of the farmers.
- Inappropriate gender-based small tools and implements.
- Low availability of farm power suited to hilly terrains for timely farm operations.
- Lack of small-scale industries and manufacturers for developing improved tools.
- Inadequate scientific man power and infrastructure for conducting research and extension activities.

- Non-existence of any major Hill Agricultural Mechanization Centre.
- Shortage of repair and servicing facilities of costly agricultural machinery in rural areas.
- Lack of proper approach roads for conveying tractors/machines etc. to the fields

4 Conclusions and suggestions

Low level of mechanization of apple cultivation in hills could be increased by adopting the improved tools/equipment for different operations. More and more R & D works on mechanization of apple crop is the need of hour so that the hill farmers may be benefited.

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