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Full Length Research Paper

Investigation of timber harvesting mechanization progress in Turkey

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This study was aimed at investigating different timber transportation methods and harvesting mechanization progress level of Turkey. Furthermore, major problems of timber harvesting in Turkey and the future principles and objectives were defined. Timber harvesting in Turkey is still carried out by manual methods due to economical, social and environmental constraints. Almost 80% of harvesting activities are mechanized in many developed countries while this value is only 13% in Turkey. Overall ratio of mechanization is relatively low. Approximate percentage of man power, animal power, machine power and skyline harvesting are 72, 15, 8 and 5%, respectively. Turkish General Directorate of Forestry's timber harvesting machines total amount was 448 in 1982, 859 in 1998, 457 in 2005 and 376 in 2009. Timber harvesting machines amount was reduced to 20 tractors (4 x 4 and assembled shovel), 133 skidding winches, 5 tractors with equipment of snow cleaner, 38 forklifts, 18 loaders, 30 skylines, 61 agricultural tractors, 3 agricultural tractors with shovel, 67 trucks, 1 barking machines as at 2009. In spite of existence of substantial number of harvesters, the amount of modern harvesting processor in Turkey is not sufficient. Different type and marked machines have not been taken into consideration to improve mechanization, and a poor standardization in harvesting is another problem in Turkey. Total machine park amount has been reduced to 56.2% between 1998 - 2009. Forest main repair shops should be opened again in Turkey.

Key words: Timber transportation, transportation methods, harvesting mechanization, forest harvesting, Turkey.

INTRODUCTION

The preparation and implementation of mechanization plans requires knowledge not only of economic, technical and management characteristics of the forest enterprise involved, but also the relationships involved in production, transport and utilization of the forest resource. When making use of the forest ecosystem for various purposes, care must be taken not to spoil the forest structure. To achieve this, forests must be used according to forestry techniques. In today's world where it is possible to use even the smallest crumbs of wood as raw material in industry, it is a real wastage to cause losses in quality and quantity during transportation and harvesting due to various reasons. The way of applying transportation and harvesting techniques has a significant effect on both the quality and the quantity of finished products. In forestry works, transportation of harvested woods from compartments is very difficult, expensive and time-consuming.

Transportation planning in forestry is divided into strategic, tactical and operational depending on the length of the planning horizon. The transportation planning is done in several steps. This deals with transportation of logs from harvest areas or terminals (supply points) to industries such as paper mills, pulp mills, saw mills, heating plants and terminals (demand points). Decisions on a strategic level are often influenced by harvesting and road building/maintenance considerations for several years. Forest operations are interventions in a forested ecosystem aimed at achieving certain management goals. These goals might require operations such as site preparation and planting, cultivation or tending of younger-stands, timber harvest, timber transportation and road building (Athanassiadis, 2000). Modern forests continue to be dramatically altered by two major anthropogenic disturbances: timber harvesting (Kittredge et al., 2003)

and permanent conversion due to land-use change (Riitters et al., 2002). Forest harvesting is an important, ongoing disturbance that affects the composition, structure and ecological function of the majority of the world's forests (McDonald et al., 2006). In forestry, like every kind of production, production works require a productive power. This productive power can be provided by both human power or animal and machines which are used by human beings.

Forest transportation should be considered in two stages. The first one is called primary transportation, which covers all activities from felling to the landings and the second one is called secondary transportation, which covers hauling activities between landings and sawmills. Secondary transport stage involves the main stage of transport of timbers, generally realized by trucks on forest roads. Primary transportation is moving timber from the harvesting site to the landing area. Cutting, bucking, skidding, landing and unloading are some of the major activities of primary transportation. Based on the results of several studies, non-mechanized (manual) cutting and skidding are relatively inefficient and more expensive than that of mechanized techniques. Despite, the increase in forest products in Turkey recently, harvesting is still done with old patterns, such as sliding, throwing, circling transport with human as well as skidding with animals on direct ground. Besides, special forest tractors and skylines are used in some areas (Aykut et al., 1997). Forest products logging is a very difficult, expensive and time-consuming operation. This problem is very important because the forests of Turkey are located in mountainous areas. The extraction of forest products without loss of quality and quantity is an important problem.

The production of raw wood material is formed from various stages that begin from the productive place to market centre. These work stages depend on each other like rings of a chain. Success and failures in each stage affect the next stage. Until recently, the forests in Turkey have encountered excessive interventions at diverse levels and densities in order to meet the country's needs for firewood. These detrimental interventions started generally in forest lands which provided easy access or transportation and continued for long, causing damage to some parts of the natural structure of our forests. Thus, only those forests located on rough lands could conserve their natural forms. This situation made it clear that these forests should be developed and improved with a view to continuously benefit from them economically. The term, "mechanization" which is defined in the dictionaries as, "all of the activities that help to create a new good or service", corresponds in forestry transportation to activities such as cutting the raw wood material, hauling, transporting and stacking it. In order to perform this harvesting rationally, requirements such as conformity to rules, safety and affordability, which make up the basis of engineering discipline, must be met. The productivity of forestry mechanization depends on many factors machine type, tree size, intensity of thinning, number of trees per hectare, terrain conditions, operator skills (Lageson, 1997; Nimz, 2002; Karha, 2003), silviculture treatment (Eliasson et al., 1999; Eliasson, 2000; Glode and Sikstrom, 2001; Hanell et al., 2000) and distances between skid roads (Harstedt, 2000; Mederski, 2006).

MATERIALS AND METHODS

Site description

Turkey, with 97% of its land area in Asia and 3% in Europe, is located between 42° 06' - 35° 51' N latitude and 25° 40'-44° 48' E longitude (Figure 1). Turkey, which is surrounded by the Mediterranean, the Black Sea, the Sea of Marmara and the Aegean Sea, has an area of 77846000 ha and 8333 km of coastline. As of the end of 2009, the total forest area in Turkey was 21188747 ha, or 27.22% of the country's area. Timberland (productive) forests occupy 15439595 ha and account for 73% of the total forest area, while coppice forests occupy 5749152 ha and account for 27% of the total forest area (Anonymous, 2008; GDF, 2009). According to 2009 data, coniferous forest occupies 53.9% and deciduous forest occupies 8.6%, mixed coniferous and decidous forest occupies 37.5% of Turkey's total forest area. In Turkey's forest, total growing stock amount is 1288124772 m^3 while the annual increment amount is 36282291 m^3 (Demir and Hasdemir, 2005; Demir, 2007; GDF, 2009).

Timber hauling standards in Turkey

Productive forests are generally found in mountainous areas which have 40-80% gradient in Turkey. Timber harvesting studies are usually practiced with tractor winches that have double or single drums. Timbers are skidded directly on surface with the shape of cable harvesting by tractor winches. Tractors are used in areas that have 30-35% slope gradient. But skylines are used in areas that have 55-75% slope gradient (Demir/Ozturk, 2005a, 2005b). Primary transportation is moving timber from the harvesting site to the landing area. Cutting, bucking, skidding, landing and unloading are some of the major activities of primary transportation. Based on the results of several studies, non-mechanized (manual) cutting and skidding are relatively inefficient and more expensive than that of mechanized techniques. Primary transportation is generally 25 - 50% of total cost of the timber harvesting works (Acar/Yoshimura, 1997; Aykut et al., 1997). In Turkish forestry, the timber logging expenditures capture the majority of the total forestry expenditures after general administrative expenditures. Taking into consideration the timber production per unit costs (with current price), 16% of total unit costs is harvesting costs (cutting/felling etc.), 31% of them is extraction cost (bunching/skidding etc.) and 30% of them is transportation cost (loading/hauling etc.) (Anonymous, 2001; Yoshimura/ Acar, 2004). Therefore, application of mechanization of skidding such as introduction of grapple skidder or using feller-buncher in cutting phase of harvesting will not only reduce total cost but also increase productivity. In Turkey, forest products are hauled in three different ways as discussed below.

Timber hauling with man power

The method of hauling forest products using manpower is done in the flat areas and in areas with slight slope in Turkey. Hauling consists of throwing the forest products down the mountain slopes,

Figure 1. The location of Turkey.

sliding and handling them.

Timber hauling with animal power

In Turkey, the method of hauling forest products using animal power makes wide use of draft animals (horse, cow, water buffalo and mule, etc.). Forest products are hauled by skidding directly over the ground, using animal power.

Timber hauling with machine power

The method of hauling forest products using machine power is applied under difficult conditions where manpower and animal power are not sufficient. Forest products are hauled by skidding directly over the ground using forest and farm (agricultural) tractors and special forest tractors (Skidders).

Besides, forest products are hauled by short, middle and long skylines types. These skyline types are Koller K300, URUS MIII and Gantner. These skylines are used mostly in East Blacksea Region in Turkey. Forest tractors are used in different regions of Turkey and forest tractors types are MB Trac 800/900/1000/1100 and farm tractors types are Steyr 768, Ford, M.Ferguson, Tumosan and Universal in Turkey. These tractors go into the yarder side by skidding roads and strips. Tractors are used in two ways in these areas. The first way is: tractors stay on the road, to draw the timber up to the road, which is found under road or on the road, with the help of winch line. The second way is to timber haulage directly on ground surface, with skidding, while tractor moves up to yarder side. MB Trac 800/900/1000/1100 tractor types are being used especially at mountainous areas in Turkey. In forest areas, with 30 - 35% gradient, MB Trac forest tractors can work comfortably. But farm tractors can work generally in areas with a gradient of 30%. The movement capacity of forest tractors is higher than the movement capacity of farm tractors. Forest tractors have many axle heights. Because of this they move more comfortably in skidding roads (Ozturk et al., 2007).

RESULTS AND DISCUSSION

The average slope of Turkey's forests is 40-80% and overall ratio of mechanization is relatively low. Approximate percentages of man power, animal power, machine power and skyline harvesting are 72, 15, 8 and 5%, respectively (Figure 2) (Erdas/Acar, 1993).

Mechanized harvesting began in Turkey in 1949 by using long distance winch skylines. Wyssen, Baco and Hintereger marked 21 set skylines widely used in the northeast forests of Turkey. Furthermore, attaining standard production in developed countries has been going on in Turkey. It is believed that mechanization of timber harvesting will improve in the near future in Turkey (Aykut/Demir, 1999; Hasdemir, 2001).

Mechanized harvesting level in developed countries is higher than in Turkey. While mechanical harvesting is about 86% in Austria, but, this ratio is about 13% in Turkey. Traditional forest harvesting is gradually being replaced by the use of harvesters, skidders and forwarders. This machinery is very popular in Scandinavia and is also in wide use in other European countries (Lageson, 1997). In Sweden, harvesters dominate thinning operations and do almost 100% of clear cutting.

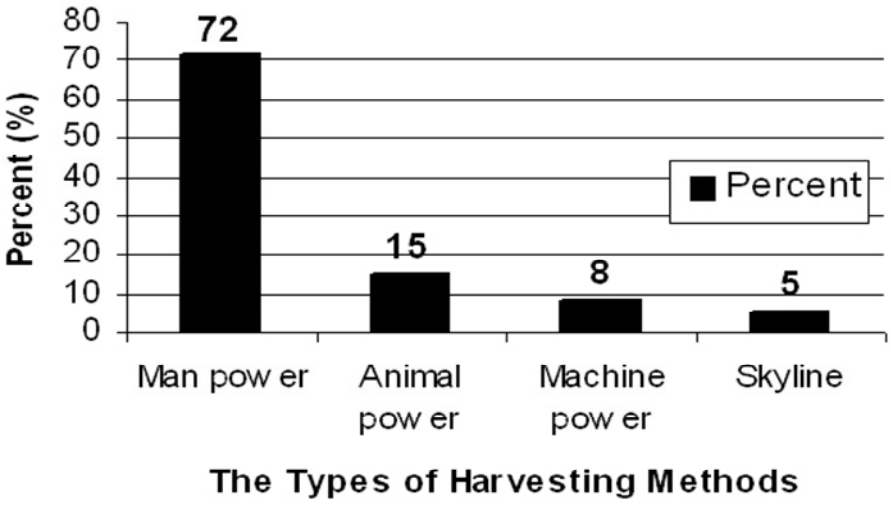

Figure 2. Approximate percentages of the harvesting methods in Turkey.

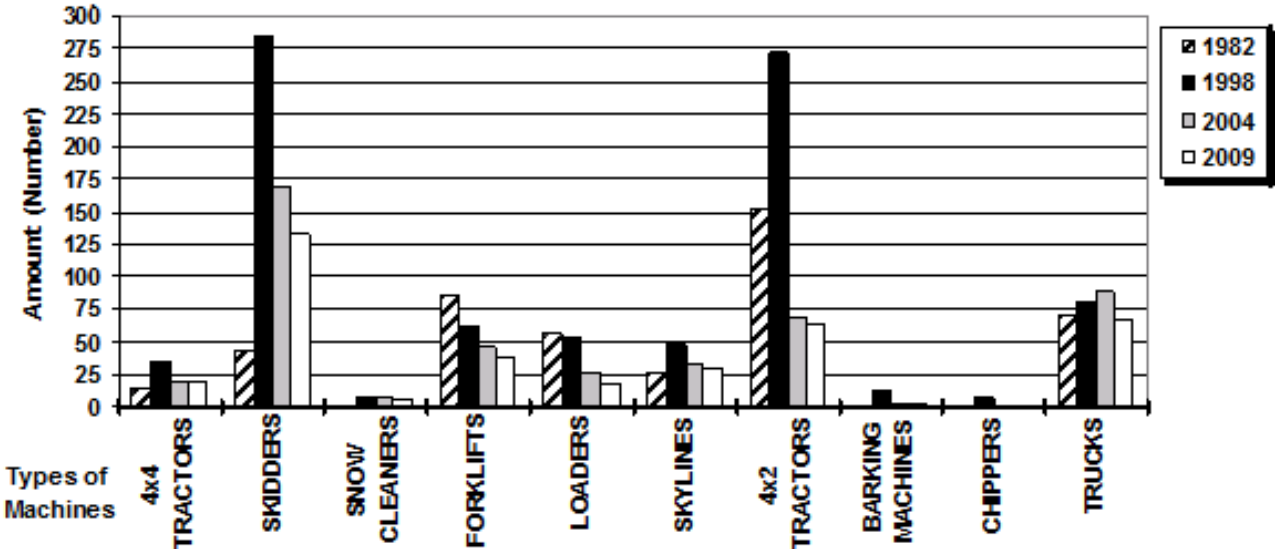

Figure 3. The mechanical park amount differences as years of Turkey.

In most of Germany, up to 30% of clear cutting is done by harvesters, but in the area of Brandenburg it has reached 70%. The high cost of purchasing forest machinery and its use is compensated for with high productivity (Gruner, 2001).

Timber harvesting machines have been improved in terms of type and amount between 1949 and 1982. In 1982, machine amounts got to 27 mobile skylines, 43 skidding winches, 85 forklifts, 55 loaders 152 tractors, 71 trucks and totally 448. (Demir/Ozturk, 2005c) (Figures 3, 4 and 5).

Timber harvesting machines amount has also improved between 1982 and 1998. Turkish general directorate of forestry has 35 tractors (4x4 and assembled shovel), 286 skidding winches, 6 tractors with equipment of snow cleaner, 63 forklifts, 53 loaders, 47 skylines, 260 agricultural tractors, 12 agricultural tractors with shovel, 11 barking machines, 80 trucks, 7 chippers and totally 859 in 1998 (Figures 3, 4 and 5).

Between 1998 and 2004, timber harvesting machines amount was reduced to 56.2% and machines park had 19 tractors (4x4 and assembled shovel), 169 skidding winches, 6 tractors with equipment of snow cleaner, 46 forklifts, 26 loaders, 32 skylines, 65 agricultural tractors, 4 agricultural tractors with shovel, 2 barking machines, 88 trucks and totally 457 in 2004 as illustrated in Figures 3,4 and 5.

Timber harvesting machines amount was reduced to 14 tractors (4x4 and assembled shovel), 133 skidding winches, 5 tractors with equipment of snow cleaner, 38

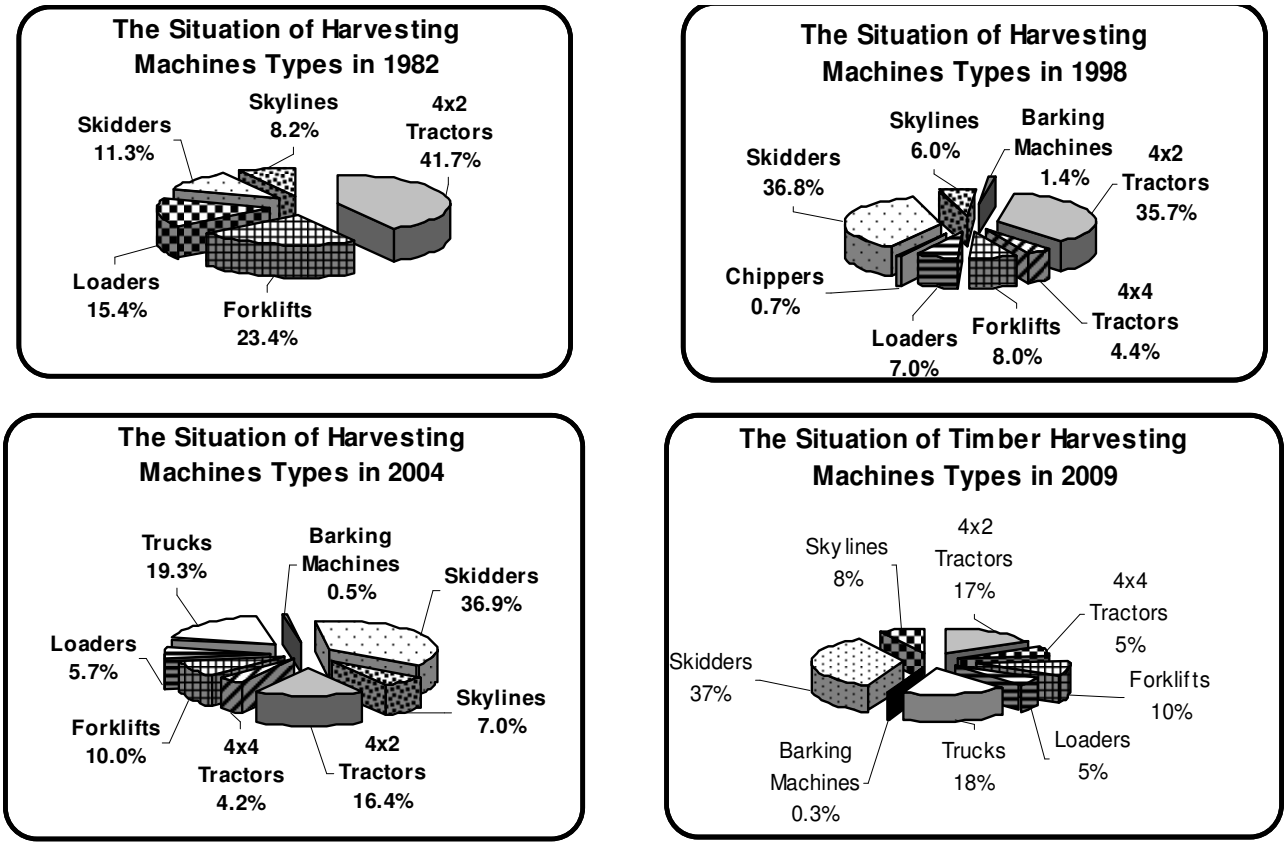

Figure 4. The situation of harvesting machines types differences as years. 1982, 1998, 2004, 2009.

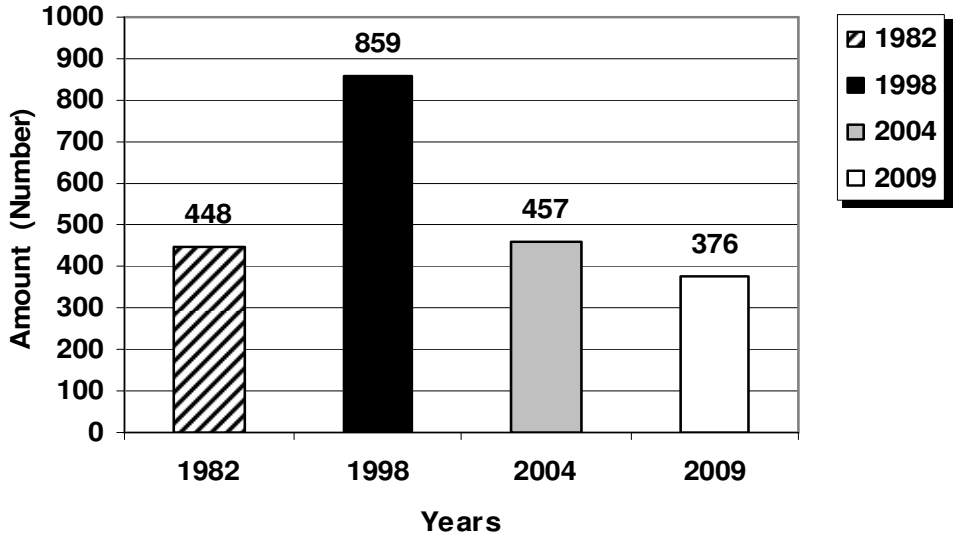

Figure 5. Total timber harvesting machines amount as years.

forklifts, 18 loaders, 30 skylines, 61 agricultural tractors, 3 agricultural tractors with shovel, 67 trucks, 1 barking machines and totally 376 in 2009 (Figures 3, 4 and 5).

In spite of existence of substantial number of harvesters, the amount of modern harvesting processor in Turkey is not sufficient. Different types and marked machines have not been taken into consideration to improve mechanization and a poor standardization in

Table 1. Current status of forest roads in Turkey (2006) (GDF, 2009).

Type	Unit	Forest Roads Needed	End of the Year 2006		Constructed Roads (%)
			Constructed	Under Construction	
New forest road construction	km	201810	143251	58559	70.98
Fire breaks	km	25544	17832	7732	69.80
Major repairs	km	61100	31923	29177	52.24
Pavement	km	54724	28277	26447	51.67
Bridge	m	23500	13697	9803	58.28
Forest roads structures	km	50000	32412	17588	64.82

harvesting is another problem in Turkey. Besides, these timber harvesting machines are generally used subjectively and aimlessly because of technical inexperience. In 1998, the directorates of main forest machines repair shops closed down (Hasdemir/Ozturk, 1997). Also, the closing of repair shops due to circumstances affected the situation of timber harvesting machine. To repair, maintain and obtain spare parts of these machine became difficult (Demir/Gandaseca, 2005; Hasdemir et al., 2007; Ozturk/Senturk, 2004).

Although this is well known, forest roads have in fact been planned primarily to satisfy the requirements of forest harvesting and timber transportation. Forest roads have been planned and constructed according to road density (m/ha) and yield/forest area (m^3/ha) criteria to meet the needs of Turkish forestry. However, forest road density should be determined according to all aspects of forestry operations. One of these aspects is in forest protection and fire fighting. All the researches done in Turkey have stated that forest road density may be 20 m/ha. Total identified forest road needs in Turkey are 201810 km, of which 143251 km, or 70.98% had been constructed by the end of 2006. As shown in Table 1, 70.98% of forest roads, 69.80% of firebreaks, 52.24% of major repairs, 51.67% of paving, 58.28% of bridges and 64.82% of forest road structures, which were planned to be constructed by the end of 2006, had in fact been completed (Demir et al., 2009; GDF, 2009). It is intended that the construction of all planned forest roads and the completion of all associated structures be achieved within 20 years. As a result, today, a substantial part of the forests of Turkey have been provided with forest roads constructed on the basis of an overall plan, and transportation by truck on such roads has often been the one and only choice.

Conclusion

Within the scope of this brief study, the following remarks can be concluded about applications of mechanized timber harvesting techniques in Turkey. First of all, harvesting plans should be analyzed based on today's forest conditions before any solid decisions are made. Turkey is a developing country, and so it might have looked effective, using manual harvesting methods in time past; however, it is important to consider long term harvesting plans which will require mechanization so that total harvesting cost will be reduced in long term. Therefore, initial investments should be considered for mechanization. Road conditions must be improved with regard to topographic and silvicultural factors. Slope of primary and secondary roads should be clearly analyzed and combined with harvesting area and final destinations.

Total timber harvesting machines amount was improved to 91.7% between 1982 and 1998, and these amount was reduced to 56.2% between 1998 and 2009. In 1998, the decision made to close down the directorates of main forest repair shops should be reconsidered and possibilities to make these directorates function more effectively be researched. Forest main repair shops should be opened again in Turkey. Level of mechanization should be determined for all of the country and then machines park should be standardized. Forest villagers should be included in logging plan and their involvement may play important role in long term mechanized harvesting. Turkey should arrange credit to finance initial cost of mechanized harvest equipment owned by local forest villagers. Training of villagers should be achieved in the form of short workshop.

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