Constraints and Prospects of Agricultural Mechanisation in Samoa

by
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Abstract

This paper discusses the Samoan topography, soil type, climate, farming systems preferred by farmers and crops cultivated. The constraints and potential of mechanization have been pointed out. Some suggestions have been put forward to encourage the farmers to adopt mechanised cultivation in order to increase agricultural production for both subsistence and commercial farmers. Agricultural mechanisation will gain a positive momentum if, at least, some of the suggested policies are adopted.

Introduction

Samoa comprises of a group of islands in the South Pacific Ocean located between 13° and 15° South latitude and 168° and 173° West longitude. It consists of two large islands, Upolu and Savaii along with seven smaller islands. It covers 3,039 square kilometers of land area with a population of about 176,848 people of which 90 % are ethnic Samoans (Government of Samoa, 2001) and a literacy rate of 98 %. The population density is 58.19 per square kilometer. The natural rate of population growth is around 2.4 %. However, emigration has reduced the actual population growth to less than 1 % per annum. Most people live in villages near the coast and normally farm the coastal strips. There is a strong trend among people to move from rural areas to the capital, Apia, seeking better work and more income opportunities. Annual rainfall varies from 2000 to 5000 mm, the lowest rainfall being experienced in the rain shadow areas in the North Western and Western coasts of both islands. Average temperature in the lowland is about 26 °C and remains fairly constant throughout the year. In the highlands the average temperature varies from 16 °C to 21 °C. The mean annual relative humidity is 83.6 % ranging from 80.4 % in August to 84.8 % in February and March.

Traditionally, agriculture has been the backbone of Samoa's economy and remains so today, primarily in terms of subsistence food supply and security (Ullah and Malaki, 2000). Agricultural farming in Samoa ranges from small subsistence farming to large commercial farming the latter comprising of only a handful of commercial entrepreneurs. Majority of farmers in Samoa are small subsistence to semi-subsistence who produce mainly for own consumption (26.35 %). About 66.38 % produce mainly for home consumption and to sell the excess produce for cash.

Agricultural mechanization is an important component for increasing agricultural production. However, farming is not only a question of labour and machinery but also is a system determined by many factors, such as, kind of crops, weather, soil type, capital, technical know-how, etc. To obtain benefits from the utilization of agricultural machinery it is essential to have knowledge about management, operations, maintenance and cost of operation. Mechanization can be used to increase the productivity of existing agricultural holdings and schemes or it can be the means of establishing some new project. Although mechanization is an important component for improvement of agricultural production, it is important to recognize

it in perspective as one of several methods and one that requires considerable capital (Rijk, 1989). The adoption of mechanization inputs into farming practices has had minimal success in Samoa's farming history. Currently, various types of farm cultivation methods are practiced in Samoa. Mechanization level varies depending on the methods and cultivation areas. These include land preparation, leveling, planting, plant protection, weed control and harvesting. But not many farmers are adopting mechanization inputs to the extent they need.

It has been of interest to study the reasons why farmers have little interest in adopting agricultural mechanisation facilities for increased production. The specific objectives of this study were:

1. to find the constraints of agricultural mechanization in Samoa.
2. to find the prospect of mechanization under Samoan agriculture, and
3. to suggest strategies that could be adopted to promote mechanization.

Topography

Of the two main islands of Samoa, Upolu is a rugged chain of volcanic cones forming a crested ridge rising to 1,100 m. Savaii consists of broad coalescing domes topped by numerous cones, the highest of which rise to 1,800 m (Kear and Wood, 1959). The landmass of each island rises gently from the mean sea level (with the exception of Eastern Upolu, which rises very steeply). Therefore, in most areas there is a flat to gently undulating coastal plain (1-2 degrees) which passes into gently rolling slopes (2-5 degrees). These in turn merge into steeper foothills (5-15 degrees) which continue sometimes steeply (15-25 degrees) until the upland plateau level is reached at about 600 m in Upolu and Eastern Savaii and at 1,200 m in central Savaii (Wright, 1963). The slopes are often dissected by almost vertical sided valleys. In general, the upland plateau is rolling and surmounted by extinct volcanic cones. The land surface is uneven due to the boundaries between different lava flows which have caused steep pitches in slopes due to large pits and rifts caused by obstructions to lava flows and collapsed steam tunnels (Wright, 1963).

Type of Soil

Hamilton and Grange (1938) conducted the first scientific study on the soils of Samoa. They indicated that the Samoan soil is relatively shallow with plenty of stones, and boulders, and contains oxide-rich minerals derived from olivine basalt. Soils are almost entirely of volcanic origin, except for a few small areas of coastal (coral) sand. Perhaps the most immediate obvious characteristic of Samoan soils is that they are mostly rocky to extremely rocky. There are 55 different types of soil. Soils are predominantly stony latosols of varying fertility (Kear and Wood, 1959). There are a lesser number and smaller areas of tuff derived soil and even fewer alluvial and colluvial soil derived from basalt (Wright, 1963). Samoan soil is generally low in potassium and or phosphate. Equitable rainfall, temperature and good soil properties tend to minimize the impact of relatively low fertility on plant production. Some soils are clay to silty clay loam in the deeper regions to sandy gravel silt loam in the lava field areas. The volcanic soils of Samoa are very young with stones and boulders found just below the surface in agriculture viable land and exposed boulders in the lava fields. These young volcanic soils have made use of machinery cultivation very difficult and expensive to maintain. So, the use of machinery cultivation method is almost non-existent.

Crops Produced

Samoa's economy is based primarily on agricultural production much of it being at subsistence level. Crops, livestock, fisheries and forestry account for 42 % of GDP. The main cash crops are coconuts (Cocos nucifera), cocoa (Theobroma cacao) and banana (Musa spp.). A major staple as well as export crop was Taro (Colocasia esculenta) which has been virtually wiped out by the taro leaf blight disease (Phytophera colocasia) since December 1993. Banana and breadfruit have become major staples since then. Another destructive cyclone caused food shortage and Samoa had to import rice. Due to the rolling terrain and the loose, rocky and volcanic soil, wetland rice cultivation is not suitable. However, upland or dry land rice could be grown due to favorable soil and climate conditions. Trees like coconuts, bananas and breadfruits are planted by making individual holes similar to taro and are the predominant crops. Other crops like cucumber, gourd, pineapple and lots of vegetables are being planted in small patches of land and, also, by depositing individual seeds or seed pieces, in most cases, rather than cultivating the area to be planted. However, the planted area is first cleared of weeds using the

Table 1 Single crop equivalent area of major crops (Govt. of Samoa, 2000)

Crop	Area in acres household sector	Total area in acres
Coconut	46,300	53,200
Cocoa	9,900	10,400
Taro	10,500	10,500
Taamu	11,900	11,900
Banana	10,700	10,700
Yam	1,300	1,300
Kava	3,000	3,000
Other crops	6,700	6,700
Total	100,300	107,700

hoe or the bushknife (Lantin, 1994). Recently, due to the destructive effects of cyclones and Taro leaf blight, farmers have sought to diversify to taamu (Alocasia microrhiza), kava (Piper methysticum) and cattle production. Other crops grown in Samoa are yams and breadfruits. **Table 1** shows the land area used for individual crops. Area under major crops grown in 1999 and 1989 are presented in **Fig. 1**. A significant variation in the cultivation of different crops in these two years can be seen.

Farming Systems

Farming systems represent an appropriate combination of farm enterprises, cropping systems, livestock, fisheries, forestry, poultry and the resources available to the farmer to raise them for food and/or profitability. Powell (2002) studied the different types of farming systems preferred by Samoan farmers. These may be stated as mixed cropping, mono-cropping, agroforestry, mixed farming and shifting cultivation. A brief description of each follows:

(i) Mixed Cropping

Mixed cropping is described as the growing of two or more crops simultaneously on the same piece of land with or without distinct row arrangement. Studies have shown that planting crops in mixtures have proven to be beneficial to the producer. Mixed cropping is popular among smallholders. In mixed cropping the farmers grow banana, taro, taamu and breadfruit under coconut. Other situations include growing plantains, taro and yams under coconuts. According to the 1999 Census of Agriculture report, crops, such as, banana, taro and taamu were commonly grown with coconut as a mixed crop. Mixed cropping also might constitute mixtures of tree crops, such as, cocoa, coconut, breadfruit, banana, citrus and vegetables, such as, cabbage, lettuce, cucumber, tomatoes, beans, okra, water cress, etc. for home consumption.

(ii) Mono-cropping

Mono-cropping basically refers to the growing of a single crop on the same parcel of land. These include bananas/plantains, vegetables/spices, fruit trees, coconuts, etc. The census of Agriculture (Govt. of Samoa, 1989) stated that nearly four-fifths of 36,500 acre was under taro as a single crop.

(iii) Agroforestry

Agroforestry can be described as any sustainable land use system that maintains or increases total yield by combining food crops and/or pasture with tree crops, with or without livestock, on the same land. Because of the anticipated benefits of agroforestry, namely, windbreaks, recycling of nutrients, erosion control and moisture conservation, some farmers prefer to go for this type of farming system.

(iv) Mixed Farming

Mixed farming describes a cropping system which involves the raising of crops, animals, and/or trees. In other words, it involves the growing of crops as well as the rearing of livestock. Mixed farming is beneficial to many small holders from the viewpoint of diverse nutrition that are available to them. Many farmers, apart from growing crops, rear pigs and chickens that are free ranging.

(v) Shifting Cultivation

Shifting cultivation refers to farming or agricultural systems in which a short but variable cultivation phase of slash-and-burn cleared land alternates with a long, equally variable fallow period. Under this system, forests, secondary bush,

Fig. 1 Comparison of different crops cultivated in 1989 and 1999 (Govt. of Samoa, 2000)

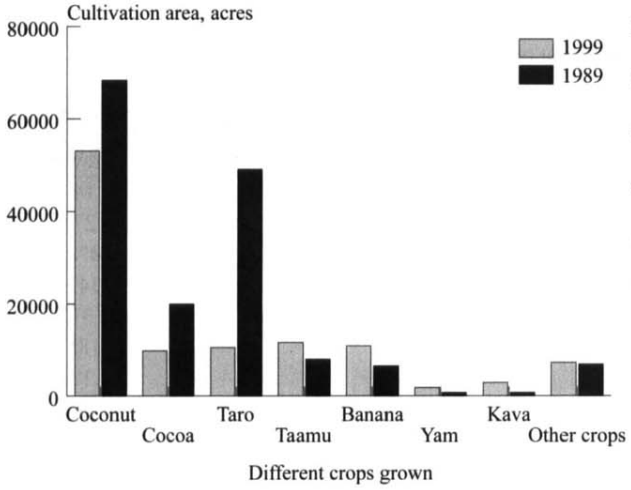
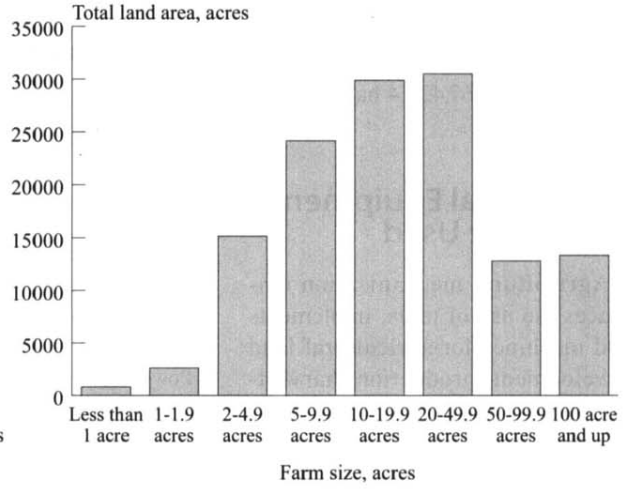


Fig. 2 Size of different farms with the total area shown (Govt. of Samoa, 1991)



woodland or grassland vegetation is cleared with simple hand tools. Shifting cultivation is an extensive system of agriculture evolved and practiced with good results in areas of relatively low population density where the farmer has enough land at his disposal and freedom to cultivate anywhere he chooses in a specified geo-political unit or region.

Farm Size

Farmers cultivate over 75 % of the total land area in many ways. Of the remaining area, 17 % is in non-agriculture use, 2 % is fallow and 3 % is bush. The average agricultural holding size is 15 acres per household with a range from less than 1 acre to about 100 or more acres under agriculture. The majority (72 %) of holdings fall between 2 acres and 20 acres (20 % at 2 to 4.9 acres, 27 % at 5 to 9.9 acres and 25 % at 10 to 19.9 acres) of agricultural activity. Crop farms are located away from the settlements while livestock are kept around the household dwellings except for larger cattle farms. Customary land ownership allows members of extended families access to land for subsistence farming. Most village land is under customary land ownership. With land reforms for access to land under way, access to free hold land has occurred in some rural areas. According to the Agriculture Census (Government of Samoa, 1999) the total area under agricultural activities is estimated at 166,485 acres (67,426.4 ha).

Agricultural Equipment/ Machinery Used

Agricultural mechanization embraces the use of tools, implements and machines for agricultural land development, production, harvesting and on-farm processing. It includes three main power sources: human, animals and mechanical. Natural power (wind and water) has been included under mechanical power, since a mechanical device is required to transfer this power into useful work. As a discipline, agricultural mechanization covers the manufacture, distribution and utilization of tools, implements and machines. Farm mechanization is a sub-category within the agricultural mechanization discipline addressing the power sources, tools, implements and machinery used on farms for crop production and processing (Rijk, 1989).

Samoa depends largely on tools imported from overseas countries like New Zealand, Australia, Germany and the United Kingdom for use in agricultural development. About ten years ago, all the tools needed for farming had to be imported. Now, some of the easier to make tools are being made locally. There is, currently, no policy on agricultural tools and implements. It is not known whose responsibility it is to devise a policy on tools and implements as this is left more or less entirely to the private sector to handle (Imo, 1992).

Each crop production and processing system uses tools and machinery, which may be either common with other crops or specialized for the crop depending upon operation and level of technology used. Samoan farmers use several implements. The traditional tools are bushknife, hoe, rakes, picks, forks, secateurs, spades, planting sticks with steel heads, locally called 'oso', stick crowbars, desuckering tool, shovels, axes, wheelbarrows, coconut dehuskers and bushknives (Atkinson, 1993). The modern implements for land clearing are chainsaws, mist blower, knapsack sprayers and brush cutters. Smaller hand tools like spades, bushknife, hoes, garden rakes, shovels and bush knives are common with farmers who have backyard vegetable crops. Vegetables including peanuts and gingers are cultivated using the pick as the main tool for breaking up the ground. Rakes and shovels or spade are used to complete the cultivation work. Weed control is done by either hand weeding with the bush knife as the main tool for cutting and dislodging the root system before uprooting by hand or by the use of weedicide. Commercial farmers use tractors to power different implements such as disc ploughs, disc harrows, rotavators and chisel ploughs. Information on major items of equipment owned, hired and or borrowed by agricultural holdings was collected in the agricultural census. Detailed information is given in the **Table 2**.

Potentiality of Mechanisation

Mechanisation has the potential

Table 2 Equipment owned, hired/borrowed, by type of equipment (Govt. of Samoa, 1999)

Type of equipment	Number of holdings	Number of items owned	Number of holdings hiring/ borrowing
Tractor	38	42	14
Roto tiller	191	356	27
Copra dryer	1,013	1,037	478
Banana injector	1,378	1,489	342
Knapsack sprayer	5,755	6,501	2,312
Mist blower	468	513	185
Power slasher	3,099	3,514	1,181
Chain saw	1,412	1,578	480
Irrigation water pump	49	55	15
Electric generator	141	145	26

to assist a large number of small farmers in the area of cultivation by designing and developing simple and inexpensive farm machinery and equipment. The soil is full of rocks, boulders and scattered trees. It is possible to take measures to make the soil rock free and clean from unnecessary trees which have no timbre value. Once these jobs are done it will be possible to bring more land under cultivation and use of machinery will be feasible. There is plenty of fallow land which can be brought under cultivation after clearing the land. The Ministry of Agriculture in Samoa already has in place a scheme whereby farmers can hire the tractor and driver plus an implement such as ripper, ridges, harrow or disc plough at a subsidised rate of WST 40.00 per hour (US$13). Farmers' response to this scheme is growing steadily.

Constraints of Mechanisation

At this moment, government has very little to do with respect to the promotion of agricultural tools and implements. This is entirely left to the private sector to handle. Perhaps, later on, the government might decide to involve in devising a policy for the promotion of appropriate tools and implements for use locally. Many Samoan farmers are not aware of the benefits of agricultural mechanization. For them to realize the benefits of mechanization it is very important to know about the available technologies. To lessen the constraints that hinder the development of agricultural mechanization, and develop ways to promote or encourage the farmers to practice agricultural mechanization, it is necessary to take measures for creation of public awareness. The following are some of the major problems and constraints that need to be addressed for rapid development of the agricultural mechanization for subsistence farms and commercial farms in Samoa:

- The presence of rocks and boulders above and just below the soil surface in large parts of the two main islands of Upolu and Savaii limit the use of machinery.
- High cost of farm machinery like tractors and implements.
- The initial cost of removing rocks, stones and boulders by using heavy machinery such as bulldozers or rippers, before using tillage machinery for cultivation, could be possible even though it is an expensive exercise but it is advisable.
- Lack of awareness campaign to apprise farmers about the availability of machinery and equipment, its use and proper maintenance, and the benefits gained from using such machinery.
- The cultural system, such as customary land ownership, inhibits commercial type farming in some ways.
- Cultural barriers in the promotion of cattle rearing which is essential in promoting animal draft power for pulling implements and carts in flat land.
- Industrial skills dwindling due to migration of people who have opportunity to acquire education and develop mechanical skills and knowledge.
- Lack of entrepreneurial skills to start metal working enterprises to produce simple tools and implements, for example, blacksmithing could be initiated at least by those who have been exposed to metal working (Lantin, 1994).
- Less dependence on agricultural land because of low population and assured remittance from family members, relatives working and residing overseas, because of strong family ties.
- Two-wheeled tractors are of limited use under certain soil conditions such as, rocky, and heavy soils etc.

Conclusions

Traditional technology is not sufficient to keep pace with the demands of commercial agriculture. To fulfill this demand agricultural mechanisation should be chosen in selective ways for both commercial and subsistence production. Some strategies or policies to the solution of the aforementioned problems to promote mechanisation both at subsistence and commercial levels are suggested. These are as follow:

- Availability of soft loans.
- Availability of appropriate and reasonably priced machines, preferably of local origin with adequate arrangements for maintenance facilities and spares.
- Train agricultural extension officers about the positive benefits of mechanization.
- Organize training workshop for local farmers whereby the extension officers will train the farmers about machinery operation and maintenance.
- Improved land tenure system will make mechanisation more attractive to farmers.
- Adopt appropriate implements for land preparation, such as a ripper for rocky soil conditions to remove rocks and boulders, and secondary tillage implements when the soil is rock free.
- There is limited information and awareness of farmers on benefits and potential of irrigation application. Creation of public awareness on irrigation methods, opportunities, technologies and benefits through information and training programs should be a part and parcel of mechanization programme.
- There is scope of sprinkler and drip irrigation systems largely due to the scarcity of irrigable water and uneven terrain condi-

tion (Pillay, 2002).

- Government should provide incentive to the interested farmers (exemption of import duty on equipments, power units etc) so that they feel encouraged to import appropriate agricultural machinery for mechanization purpose.
- Proper strategies of land ownership system can be used to an advantage as there is land consolidation in the extended family.

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