Tea Q. 53 (1/2), 11-18, 1984 Printed in Sri Lanka

COMPARATIVE STUDY OF THE RELATIONSHIP OF TEA YIELDS AND AREA VARIATIONS DUE TO SLOPES IN HILLY TERRAIN USING AERIAL PHOTOGRAPHS AND SURVEY MAPS†

M. B. A. Perera

(Tea Research Institute of Sri Lanka, Talawakele, Sri Lanka)

and

R. Humbel

(Sri Lanka/Swiss Remote Sensing Project)

The area obtained by standard land survey methods for steep lands is less than actual land surface. Tea in Sri Lanka is often cultivated on mountain slopes where in some instances the slopes are more than 30 degrees. This study compares the actual land surface with the standard survey area and their relationship to slope, number of tea plants per unit area and tea yields.

INTRODUCTION

The hectarage obtained by standard land survey methods or by photogrammetric methods for steep slopy lands is less than their actual land surface area.

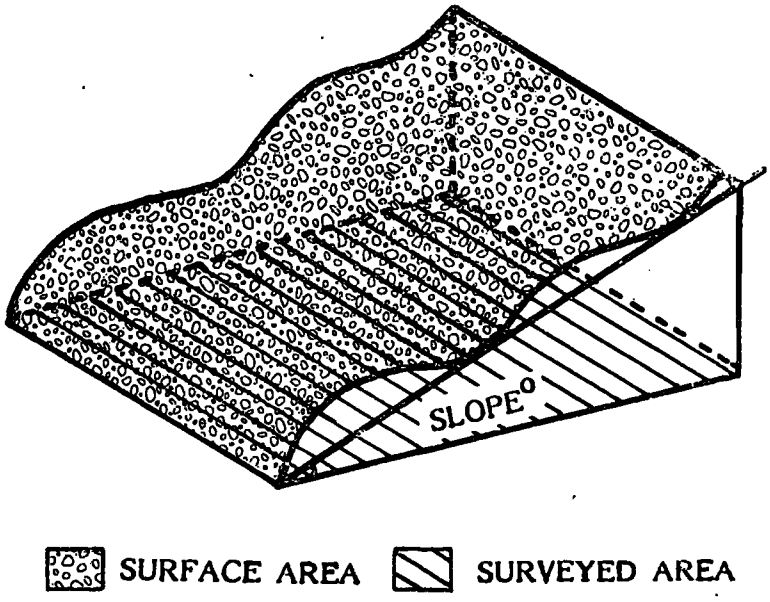


Fig. 1. — Variation of actual and surveyed land area with the variation in slope

† This paper was presented at the Fourth Asian Conference on Remote Sensing held in Colombo, Sri Lanka from 10-15, November, 1983.

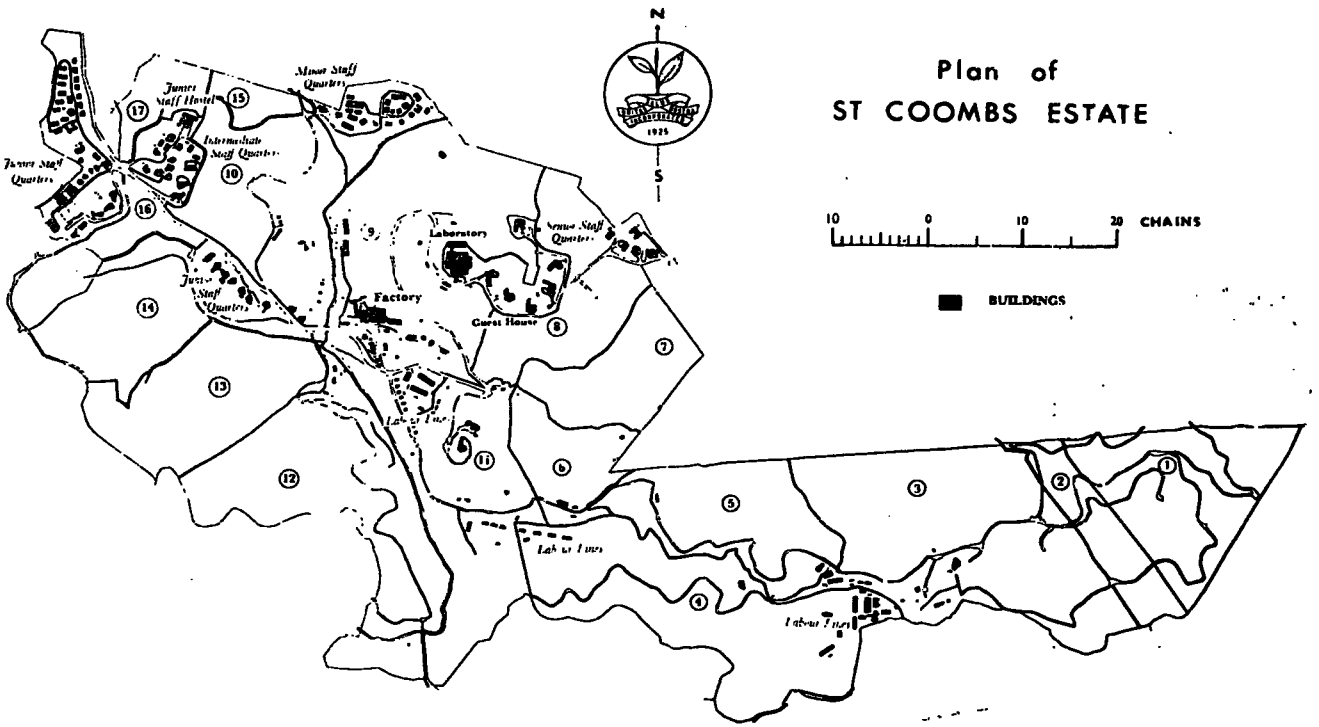


Fig. 2. — Estate plan with field demarcations

Figure 1 illustrates how the actual land surface area varies compared to the surveyed land area with the variation of slope. The actual land surface area can be determined by obtaining the slope of the land and surveyed area.

$$\text{Actual Surface Area} = \frac{\text{Surveyed area}}{\cos(\text{Slope}^\circ)}$$

The difference between the actual land area and the standard surveyed area is greater when the degree of slope is greater. Tea in Sri Lanka is often cultivated on mountain slopes where in some instances the slopes are more than 30 degrees.

It could be an useful exercise to find out whether there is any relationship between yields and the number of plants per unit area with the varying degrees of slope, as all relevant records are maintained on standard surveyed area basis with no consideration of actual land surface area.

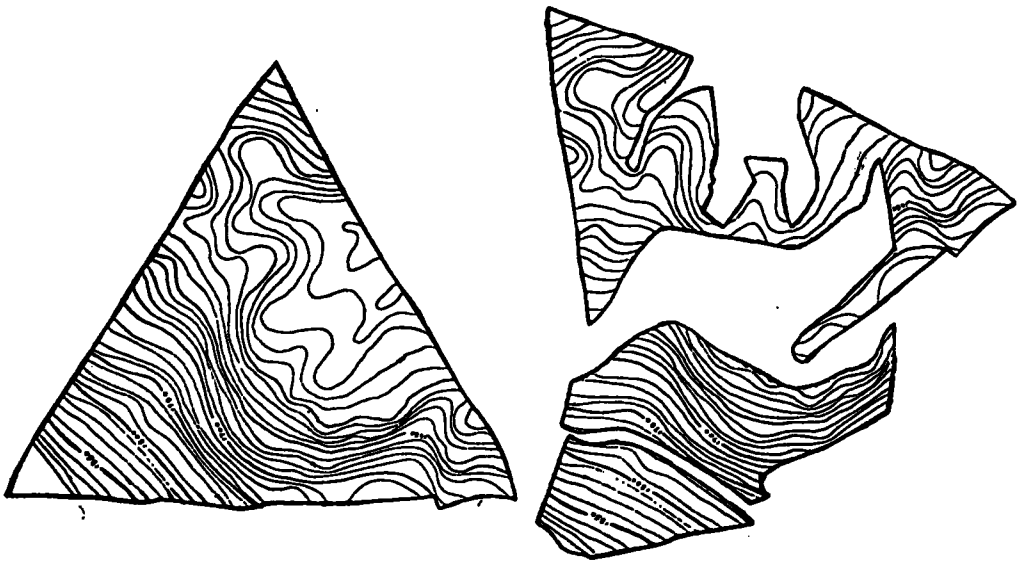
This study compares the actual land surface area with the standard surveyed area and their relationship to slope, number of tea bushes per unit area and tea yields. An attempt is also made to show the best correlation of the tea yields with the actual or surveyed land surface and with the degree of slope of the land.

METHOD OF COMPARISON

Selected fields from an up-country tea estate (St Coombs Estate, Talawakele, Sri Lanka) were chosen for the study (Fig. 2). This estate is situated in the Nuwara Eliya district of the Central province of Sri Lanka. The estate has an elevation range of 1350 - 1800 meters amsl. The slope of the lands where tea is planted varies from 30 to 40 degrees.

St Coombs Estate, like any other plantation is divided into a number of fields for easy management, and maintenance of records and accordingly, the yield and number of plants are recorded on field to field basis. It was necessary to consider each field as one unit for comparative studies, although the division of the fields is not done according to the terrain of the land.

For the present study, tea fields with fairly homogeneous slopes on the estate were selected. A ten meter contour map of the estate was obtained using the relevant stereo pair of the aerial photographs under a stereo plotter. The fields were sub-divided further into smaller units in order to obtain units of homogeneous slopes within each field (see Fig. 3).



Contour plan of field No. 1 Sub-division of the field

Fig. 3. — Contour plan and sub-division of the field (tea area)

After sub-dividing the fields into units the number of contour lines within at given length was counted. Three or more such measurements were taken to calculate the mean slope of each unit.

The scale of the contour map prepared is 1 : 3160; when the number of contour lines within the given length (l) is c, the height of the land in reality is 10c.

Hence the slope (s)°, can be calculated thus:

$$\tan s = \frac{h}{1} = \frac{10c}{1 \times 3160}$$, where h is the height of the slope.

After calculating the slope for each measurement the mean slope, i.e. the arithmetic average of s, for each unit can be obtained.

The standard surveyed area where the tea is cultivated in each unit is obtained using an electronic area meter.

The mean slope for each field is then calculated using the mean slopes and areas obtained for each unit.

$$\text{Field slope (l)} = \frac{(s_1 \times a_1) + (s_{11} \times a_{11}) + (s_{111} \times a_{111})}{a_1 + a_{11} + a_{111}}$$

Once the surveyed land area and mean slope of each field is known, the next step is to calculate the actual surface area for each field using cosine value of the degree of slope.

RESULTS

TABLE 1 — *Relationship of surveyed area to actual surface area of tea fields with their yields and plant density.*

Field No.	*Type of* tea*	*Surveyed area -ha*	*Slope°*	*Actual surface area -ha*	*Yield kg*	*Number of** plants*
1	M	8.89	20.7	9.6	17985	—
2	VP	3.12	12.4	3.2	7071	38300
3	VP	14.42	9.4	14.7	26244	183200
4	M	12.40	16.6	13.0	25556	—
5	VP	7.88	15.3	8.2	16312	91300
6	M	3.83	16.7	4.0	8287	—
7	VP	4.31	18.8	4.6	9189	48800
8	VP	6.29	14.3	6.5	12656	74700
12	S	11.97	14.6	12.4	22312	—
13	S	8.26	18.4	8.8	17924	—
14	M	4.96	14.7	5.2	9935	—
17	VP	1.87	39.2	2.4	4372	24600

*M — Mixed - clonal and seedling tea

VP — Clonal tea only

S — Seedling tea only

**Records available only for six fields

TABLE 2 — *Variation of yield with plant density calculated by different methods.*

Field No.	*Type of* tea*	*Slope°*	*Yield kg/ha (Surveyed)*	*Yield kg/ha (Actual - surface)*	*Plants/ha (Surveyed)***	*Plants/ha (Actual - surface)***
1	M	20.7	2023	1873	—	—
2	VP	12.4	2259	2210	12236	11968
3	VP	9.4	1820	1785	12705	12462
4	M	16.6	2016	1966	—	—
5	VP	15.3	2070	1989	11586	11134
6	M	16.7	2164	2017	—	—
7	VP	18.8	2132	1998	11323	10609
8	VP	14.3	2012	1947	11876	11492
12	S	14.6	1864	1799	—	—
13	S	18.4	2170	2037	—	—
14	M	14.7	2003	1911	—	—
17	VP	39.2	2338	1822	13155	10250

*M — Mixed - clonal and seedling tea
VP — Clonal Tea only
S — Seedling tea only

**Records available only for six fields

Table 1 illustrates the relationship of the surveyed area and the actual surface area with the yield and number of plants. The yield figure given is the mean obtained from ten year (1971 - 1980) yield records. Records of number of plants planted in the respective fields were available only for fields where V.P. Tea (Clonal Tea) is planted exclusively.

In Table 2 is shown the variation of yields and number of plants calculated on standard surveyed area basis and actual land surface area basis.

Figures 4 to 7 illustrate various correlations of data obtained for the study.

DISCUSSION

As there is a very high correlation between the actual and surveyed areas ($r = 0.9990$) the yield differences with surveyed and actual areas are very small (Fig. 5).

However there is an increase in yield with the increase of slope ($r = 0.66$) when the yield is based on the standard surveyed area. A comparison of yields based on actual surface with slope does not give this correlation as the effect of slope is already counted for the actual surface area (Fig. 6). But on the other hand the number of plants per hectare does not show any significant variation with slope when based on surveyed area. However when the number of plants is based on actual surface area there is a reduction with the increase of slope (Fig. 7). This could be attributed to the fact that the area occupied by drains and other constructions for soil and water conservation on steep lands reduces the number of points for planting.

The above observations show that there is an increase in yield with the increase of slope even though there is no significant increase of the number of plants. This means that a tea bush on a steep land would yield more than a bush on a flat land. However, further in depth studies on various selected sites should be done to establish this assumption.

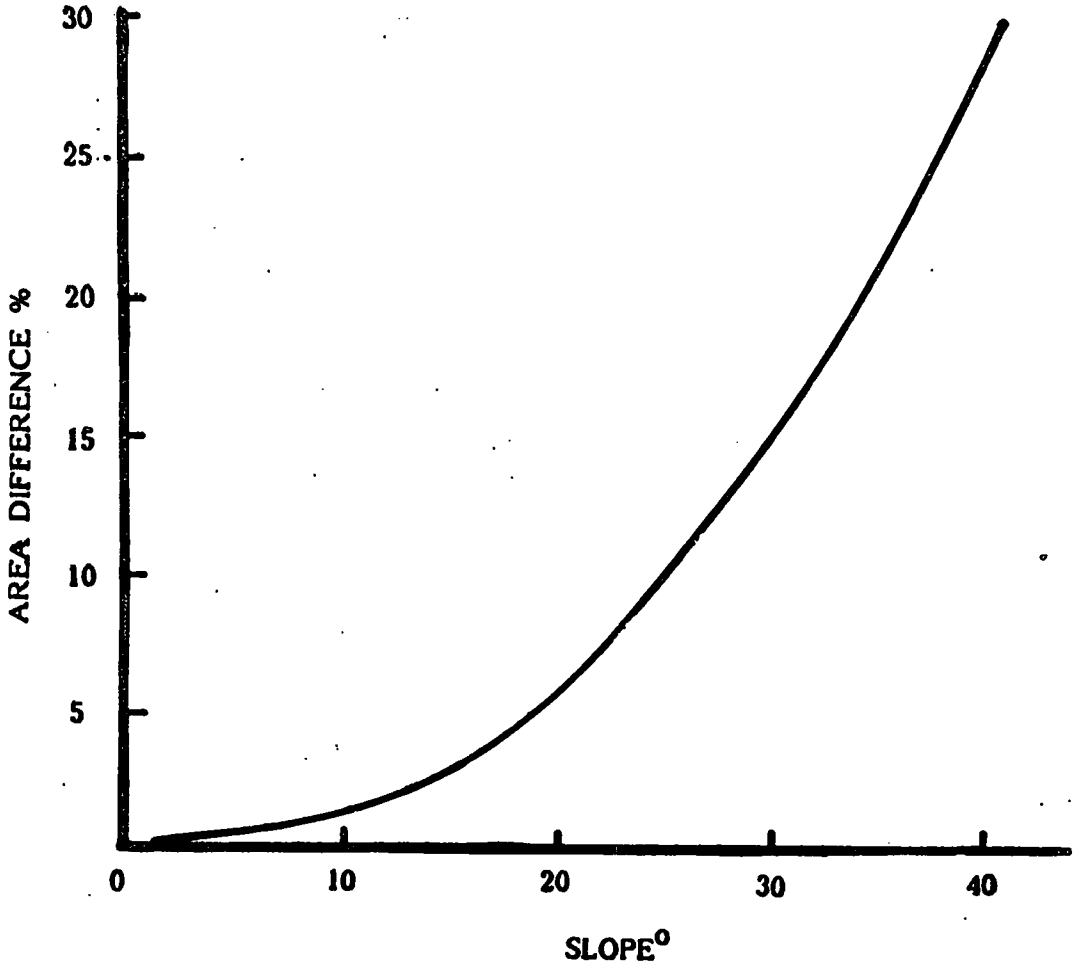


Fig. 4. — Relationship between per cent area difference and slope

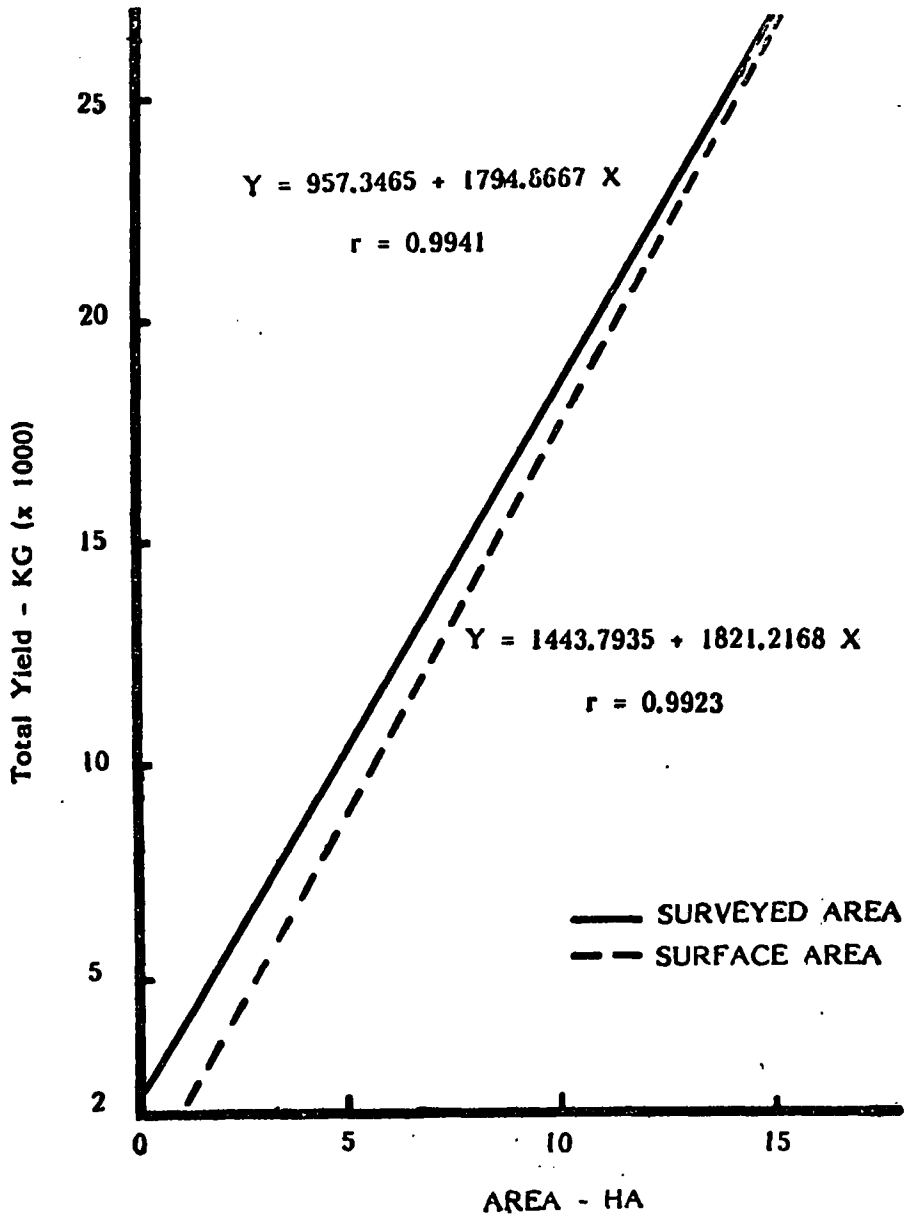


Fig. 5. — Correlation between total yield and surveyed as well as actual surface area

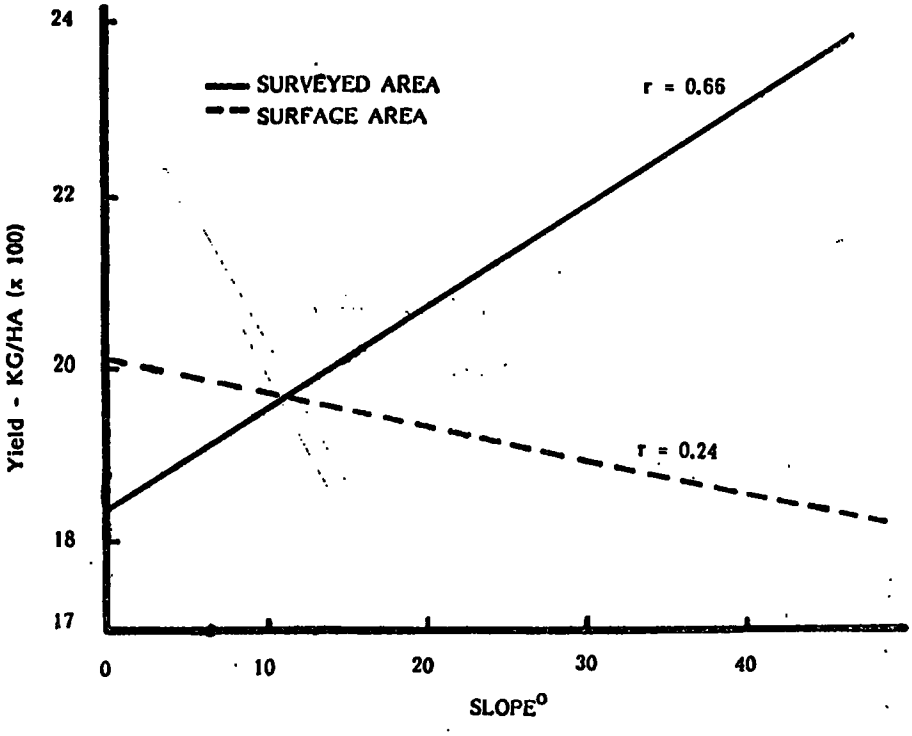


Fig. 6. — Relationship between yield and slope (surveyed and actual surface area)

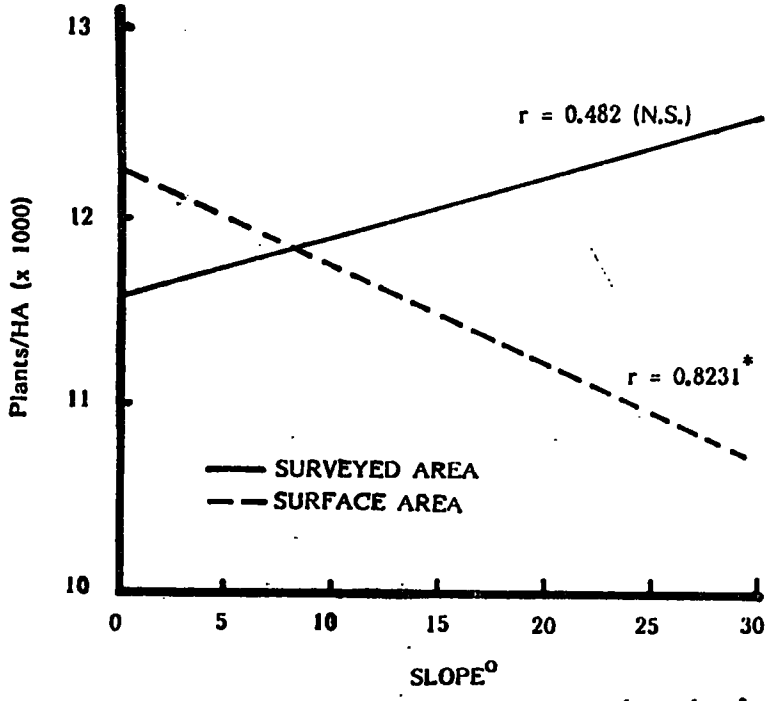


Fig. 7. — Relationship between plant density and slope (surveyed and actual surface area)