3. Hedge Planting

From a standpoint of dividing the risk inherent in any agricultural enterprise, especially in East Java and in certain parts of Mid Java, much research and commercial trials have been expended on attempts to find a planting system allowing mixed plantings of the two main perennial crops of those regions, rubber and Robusta coffee (*Coffea robusta* L.). Before the 1934 rubber restriction was enforced, the solution was found in the so-called "avenue system." In this planting system, the rubber usually was grown in hedge-rows, 2 to 3 meters between the trees and 8 to 9 meters between the rows, giving a stand of about 600 trees per hectare. The coffee was planted in the wide spaces between the rubber rows. Since the rubber would close the lanes, after a few years, the coffee could be kept only about 12 to 13 years before it had to be taken out for lack of enough light to ensure its growth. The coffee, therefore, could be regarded as a "catch-crop" and the rubber as the main crop (Kuneman 1939 a, b).

a. Habit of the trees in hedge plantings.

In addition to the points mentioned previously concerning planting density experiments, the following points are of special interest with regard to rubber hedges:

(1) Crown shape and growth of hedge trees.

(2) The relationships of light, number of branches (limbs), size and direction in which the branches are developed.

(3) The root systems of hedge trees.

(4) The yield and bark renewal of hedge trees.

(1) Crown shape and growth of hedge trees.

Heubel (1939 a), de Jong (1938, 1940) and Schweizer (1940) studied the crown form and type of branching with clones and seedlings in connection with space competition. As a general conclusion, it was found that with trees in narrow planted hedges, the girth development is intermediate between that of trees planted in narrow non-hedge patterns and that of trees standing in wide non-hedge patterns. Certain points in the growth curve of trees in narrow planted hedges show a similarity with the growth curve of trees planted in narrow square stands, such as a slight retardation in the average girth development during the 4th year and the greater average height found with the trees planted in both patterns, when compared with trees planted in wider spacings (Table 37).

In a seedling hedge test at the Kaliwining Experimental Estate of the Besoeki Experiment Station at Djember, East Java, planted 1 meter in the rows apart without thinning, the criterion of tappability was reached by 30% or about 470 trees per hectare by the end of the 5th year. If the I.R.R.A. tappability criterion is used (a minimum of 130 trees per hectare measuring 45 cm. in girth at a height of 100 cm.), the tap could have been opened as early as the end of the fourth year. There exists, however, a considerable variation between clones (and naturally also between seedling progenies) in this respect.

TABLE 37

COMPARISON BETWEEN THE AVERAGE GIRTH OF TREES 4 YEARS AND 10 MONTHS OLD PLANTED IN HEDGE FORMATION AT THE BESOEKI EXPERIMENT STATION, DJEMBER; AND THE SAME MATERIAL PLANTED IN A SQUARE PATTERN AT RENTENG ESTATE, DJEMBER, EAST JAVA

Locality of trees	Planting system	Girth (cm.)	Bark thickness (mm.)	Height (m.)
Besoeki Expt. Sta.	Hedge	43	5.3	16
Renteng Estate	Square	46	5.9	13

(After Schweizer 1939 a)

These differences are explainable on the basis of the crown habit of the clones or seedlings. It has been found that the reaction of the crown habit towards planting pattern is specific as each clone or family has been found to react differently towards square, triangular, rectangular, and hedge-patterns, especially under conditions of narrow spacing. It is not yet possible, however, to present a generalized description as to the characteristics of the crown most desirable in clones and seedlings which are to be used for planting in the narrow hedge patterns. In this connection the following points require consideration in the selection of planting material: a) clones whose inner branches tend to keep their leaf-bearing twigs and leaves for some distance below the outside of the crown as, for instance, AV 49 and Tjir 1 (Figure 73); and, b) clones having the characteristic of developing shoots from latent buds when the crown is exposed to the sun. Such clones or families, when planted in dense patterns other than hedge tend to retain their leaf-bearing twigs only at the tip of the branches as the canopy closes in. A clone showing this characteristic is BD 10. The latter will regenerate a full crown within 2 to 3 years when the surrounding trees or planting are pruned so as to allow sunlight to penetrate to the base of the branches (Schweizer 1939 a, 1940).

Fig. 73. Shade tolerance of Hevea as shown by a 12-year-old planting. On the right of the picture the clone AV 49 is planted. It maintains all of its branches even in its dense, dark cover. On the left, another clone is planted which loses all of its shaded branches (AV 49 has "shade-tolerant" branches; the other clone does not.) (Photo by Schweizer, de Bergcultures 14 (52), 1940)

(2) The relation between light, number of branches, size and direction in which the branches are developed.

In hedge plantings it has been found that most of the branches develop on the side of the trees facing the open lanes (Schweizer 1939 a, 1940), as a result of which they acquire a bilateral shape. Although in the beginning the trees in the hedges owing to competition for crown-space sometimes develop oval-shaped trunks, this condition usually corrects itself. As Hevea brasiliensis is to some degree phototropic, it has also been found that the number and size of the branches show differences from the normal growth under uncrowded conditions: e.g., the crown becomes asymmetrical with varying exposures to the sun, depending upon the compass direction of the hedges. In Indonesia, all rubber trees tend to orientate themselves in a northerly direction, as a result of which they often lean slightly northwards. According to Schweizer (1940) and van Steenis (1938), this phenomenon is a result of the combined effects of the predominantly northern declination of the sun (roughly two-thirds of the year) and the daily variations in light intensity. They found the early morning hours to have the largest insolation while the light became much more diffuse during the afternoon hours. However, the period of southern declination coincides with the West Monsoon or rainy season, and it is at this season the main growth takes place. It is this fact which, according to the results of tests planted to ascertain the point, compensates in large part for the lack of light on the shaded side of the trees during the period of northern declination of the sun when the hedges are planted in an east-west direction. In this case, Schweizer (1939 a) counted on the south side of the hedges twice as many new shoots arising during the period of southern declination than on the north side. For this reason, the crowns do not grow as asymmetrically as might be expected and in consequence the trees do not lean out of the row to the extent they do when planted in a north-south direction. Based on this observation, Schweizer (1939 a) advocated the planting of rubber hedges in east-west direction.

In Java it has been found advantageous also to use high-stumped buddings or seedlings for hedge plantings, since they have been found to give particularly even development (Schweizer 1940). The advantages are:

(i) Early, sturdy branching results in forming maximum leaf surface and maximum girth growth more rapidly.

(ii) In case seedlings are used, the high-stumped plants develop more nearly cylindrical stems than do non-stumped seedlings, the differences running as high as 10%.

(iii) High stumped seedlings and buddings are more resistant to wind damage than unstumped material.

(iv) The stems and crowns remain more nearly in the line of the row.

(v) Replanting, if any, may be done during the first and second years after planting in the field with stumps of like age.

(3) The root system of hedge trees.

The roots of hedge trees, compared to those of free-growing single trees which may be regarded as growing under the optimum space conditions, have been found extended much farther laterally. The roots of rubber growing in narrow square pattern were discovered to be much shorter than those of either free growing or hedge trees (Schweizer 1939 a). Measurements on hedge and free growing trees about 15 years old gave the following data:

(i) Hedge trees - length of laterals 18 meters.

(ii) Free growing trees - length of laterals 11 to 12 meters.

(4) The yield and bark renewal of hedge trees.

From the data and discussion presented in the preceding sections it is obvious that contrary to other planting patterns, the hedge trees combine a large crown with strong root system. (Schweizer (1939 a, 1940) presented a number of data obtained from small trial hedges in comparison with those obtained from normal (square or rectangular) plantings.

In so far as these limited data allow conclusions to be drawn, they may be summarized as follows:

(i) Good yielding clones tested in normal planting patterns remain good when tested in a hedge formation.

(ii) The production per tree in a hedge formation increases normally. (Some data from a 7 year old seedling hedge planting of the Besoeki Experiment Station may illustrate this. The planting distance for this test was 1 x 10 meter or 1000 trees per hectare. The tap was opened in the 4th year at 50 cm. above the ground, using the system S/2, d/2, 100%. The production during the 5th year or 1st tapping year was 1.1 kg. per tree, 1100 kg. per hectare; 2nd tapping year 2.3 kg. per tree, 2300 kg. per hectare.)

(iii) the Production per hedge tree is lower in the beginning than that of trees in other planting patterns; however, the large number of trees planted results in yields per area far higher than ever can be obtained with other patterns.

(iv) The yield per unit of tapping-cut length is practically the same with both hedge trees and trees in normal square patterns. The quality of the bark, therefore, does not seem to be affected by the hedge system. For instance, from a BD 5 hedge in the Djember area, the following data were obtained:

Yield per 10 cm. of tapping cut on hedge trees 3.74 grams.

Yield per 10 cm. of tapping cut on trees in square patterns 3.92 grams.

(v) The yield per hedge tree at an older age (20 years) in an experiment at Kali Djeroek Estate, Djember, East Java, was nearly the same as that for trees growing in square patterns. If it is considered that at this age the trees in both patterns have already been thinned to their ultimate stand, this means that the yield per unit of tapping cut length of the hedge trees becomes considerably higher than that of the trees which have from the beginning been standing in normal patterns. In short, the hedge tree of 20 years of age, as a producing unit per area, is more valuable than the tree grown in any of the other patterns.

(vi) Considering the density of the stand in hedge plantings, the bark renewal has been proved to be very good, as the data in Table 38 show.

The above-stated surprisingly good results with rubber in hedge formations must be ascribed to the large development of the crowns (Figure 74) and to the extended root systems of the trees. The hedge

Fig. 74. Ten-year-old seedling hedge planting of *Hevea* at Kaliwining Experimental Estate. Note the large crowns. On the right an *Erythrina* nursery has been laid out under the shade of the rubber. (Photo by Schweizer, de Bergcultures 13(3), 1939)

system of planting, in fact, combines the advantages of a dense stand (i.e. high production per area) with the advantage of wide planting, resulting in good growth and good bark regeneration.

There are, however, clones and families which through specific properties of habit and their reaction to space and sun, will prove to be more useful than others for hedge culture of single or mixed crop plantings. Selection has just begun in this field and future tests of planting material should have their design adapted to include this point.

8. Other Crops Planted with Rubber in Temporary or Permanent Stands.

The use of mixed rubber/other crop plantings, has gained in importance as a means of dividing risks and in emergencies for providing food while developing the rubber plantation as in time of war, and as a measure to increase the prosperity of small holders, or small farmers.

Mixed plantings of rubber with food and other crops as soybeans, cassave, upland rice, citronella grass, coffee and cacao have been made since the early 1920s.

Available experimental data on mixed plantings of Hevea and food crops are only few in number. The main objective of experimenting in this field was to find out whether the food crops would have an injurious effect on the rubber. Since most of the food crop experiments were carried out in rectangular, square or triangular patterns, the food crops were planted between the young rubber. The experiments were made for the most part on plantations in collaboration with the Experimental Stations. The set-ups were usually such that either clean-weeded mono-rubber controls, or ones with a cover of legumes, as Centrosema, Calopogonium, etc., could be compared with the mixed treatment.

the rubber was in this instance 6 x 7 m. As many as three harvests during a period of 15 months could be obtained (Vollema 1934). The use of soybeans in this way, however, is confined to localities with specific climatic and soil conditions.

van Leeuwen (1940) obtained indications that showed one harvest of upland rice on clearings of virgin land on very phosphate-deficient laterite adversely affected the growth of the rubber.

The West Java Experiment Station planted in a young rubber test plot at the PEWEJA Experimental Estate an experiment with upland rice followed by peanuts. These two crops were a partial failure, so that no conclusion concerning their usefulness could be obtained; however, the rubber did not show any effects of these food crops (van Schoonneveldt 1948).

van Schoonneveldt also reported on the effects of a cassava (Manihot esculenta Crantz) crop in young rubber. (The data for this experiment are tabulated above.) The cassava culture lasted only 14 months (this crop was planted shortly before the Japanese invasion and was prematurely harvested at that age during the occupation) but in this short period it had already caused a terrific growth retardation of the rubber, although the latter trees were each fertilized with 1 kg. of rock phosphate and 1/8 kerosene tin full of stable manure (roughly 1/25 cu. meter). This experiment suggested that the cassava had promoted the spreading of Fomes lignosus, a dangerous root rot disease of Hevea. It is interesting to note that this experiment was made with high-stumped buddings of the very vigorous growing clone LCB 1320.

In all of these experiments, the distance between the rubber and the catch crop was kept at least 1 meter with a clean ring of 2½ m. (the standard clean tree ring) being maintained throughout the experiment. Citronella grass was found to be very competitive also.

The situation becomes completely different when Hevea is planted in avenue or hedge patterns. These two systems allow interplanting with other crops on a profitable basis. The oldest known mixed plantings of this type in Indonesia are where rubber in an avenue system was interplanted with Coffea robusta L. The systems were evolved in the monsoon climate regions of East Java where Hevea grows more slowly due to a pronounced dry season each year. As a result of this, 8 to 9 years growth usually are necessary before the rubber yields reach the level of those in the more humid regions in West-Java and Sumatra (Kuneman 1939 a), since tapping is usually stopped entirely during the dry monsoon.

Hevea was introduced as a new crop to coffee plantations where both the proprietors as well as the plantation managers were entirely familiar with coffee. It was therefore understandable that soon Coffea robusta was interplanted as a catch crop to bridge the years needed for the rubber to get well under way. This commercial experiment proved to be a full success, both from an economical as well as from an agricultural standpoint.

The older mixed plantings were those in which the rubber was put out in so-called avenues, the planting distance being 2 m. in the rows with the rows 8 to 9 m. apart (Kuneman 1939 b). The Robusta coffee was usually interplanted in the avenue space at about the same time as the rubber, either the rubber first or the coffee first.

Rubber will normally tend to close its crowns after 7 to 10 years, depending on the kind of planting material and local environmental conditions. Although the Robusta coffee can stand shade, in fact needs shade to a certain extent for its optimum health and healthy productivity (Gandrup 1935), over-shading by the gradual encroachment of the rubber will ultimately result in a decline in the coffee yields, so that the latter must be removed. In the meantime, however, under conditions of good soil and upkeep the Robusta coffee starts producing in its 3rd year, so that several coffee harvests will have been made before the rubber shade becomes too great (Kuneman 1939 a, b; Schweizer 1939 a).

The planting distance of the coffee between the rubber is usually in a square pattern, 2½ x 2½ m. or in an avenue pattern, 1.8 x 3.6 m. (Ultee 1949). Gradually, it has become a tendency to plant the rows of rubber further apart, in its most extreme form up to 20 m., in order to profitably work the coffee longer, and more than two rows of the latter were put in. To maintain a high number of rubber trees per hectare the rubber in the rows were planted as close as one meter apart and thus envolved the "hedge" system discussed earlier. The mixed rubber-hedge/coffee plantings are of recent date. The Hevea trees used for such plantings are of the highest possible selected quality of seedlings, budded stumps as well as stumped buddings (Figure 76); (Schweizer 1939 a).

Fig. 76. AV 188 three and three quarters years old planted 1.8 m. apart in a hedge system at Kalisanen Estate. Coffea robusta is planted between the hedges. (Photo by Schweizer, de Bergcultures 14 (52), 1940)

In the wider planted rubber-hedge/coffee systems the coffee is shaded separately by Leucaena trees since the rubber shade is too limited to give even shade to the entire depth of the strip (Figure 77). An important point is that no growth and yield interference from the coffee on the rubber has been found nor vice versa, until the shade of the rubber becomes too dense.

Cacao has also been planted instead of coffee as a semi-permanent crop between rubber hedges. However, this type of mixed planting, is still in its experimental stages, the first large-scale commercial trials having been planted in 1940/1941 so that if the Japanese occupation has not disturbed these

Fig. 77. Leucaena glauca shade in Robusta coffee (Coffea robusta) planted as a mixed stand with rubber in hedges. (Photo by Schweizer, de Bergcultures 13 (3), 1939)

plantings the first results may be expected soon.

The use of food crops in connection with hedge-planted rubber has not been reported. It may be safely assumed, however, that the ill-effects described previously will also be found in such a system, unless perhaps the strips planted to such crops are kept well separated from the rubber with proper fertilizing and upkeep applied. Adequate experimentation must be performed first before this point may be cleared up.

Fig. 78. Derris elliptica var. woeloeng planted between stumped buddings of clone BD 5 in rectangular pattern at the governmental estate, Merboeh. The Derris is provided with stakes on which to climb, this stimulating both the growth and the supply of propagation material. (Photo by Los, de Bergcultures 12 (30), 1938)

An experiment with Deriss elliptica between young rubber gave negative economic results due to poor growth so far as this catch crop was concerned. The rubber was not affected by this legume (Pfältzer and Vollema 1949). However, many companies have already started to plant Derris as a catch-crop on a commercial scale on flat land. Used between young rubber trees, the results have been justified on an economic basis for both the Derris and the rubber. Figure 78 gives an idea of how this legume is cultivated between rubber. The Derris is harvested when it has reached the peak of its rotenone content, which with the Indonesian-developed commercial varieties is obtained in 22 to 24 months.

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