VII

STRIP SYSTEMS

1. GENERAL TERMINOLOGY AND CLASSIFICATION

*Strip Systems* comprise certain systems differing in detail but having one common characteristic, namely, that the coupes take the form of comparatively narrow strips, which have certain advantages, mainly of a protective character, over large coupes. The French term applied to a strip felling is *Coupe par bandes*. The following German terms may be mentioned:

*Saumschlag*, *Saumhieb* (strip felling); *Saumschlagbetrieb* (strip system). These terms denote very narrow strips, say up to half tree height or little more, cut along the edge of the old wood (*Saum*, Eng. seam, i.e. edge or border, hence *Absäumung*, meaning regeneration obtained on a narrow strip along the edge of the old wood).

*Schmalschlag*, the same as *Saumschlag*, but not so much used.

*Streifenschlag* denotes broader strips than *Saumschlag*.

For our purpose it will be convenient to classify the various forms of strip system as follows:

1. The shelter-wood strip system.
2. Wagner's *Blondersaumschlag*.
3. The strip and group system.
4. The progressive clear-strip system.
5. The alternate clear-strip system.

2. THE SHELTER-WOOD STRIP SYSTEM

**General Description.** The shelter-wood strip system (Ger. *Schirmsaumschlag*, *Saumweiser Dunkelschlag*) was evolved out of the uniform system for protective reasons. Under the uniform system the procedure of beginning regeneration fellings in the E. or NE. of a compartment and working towards the W. or SW., against the prevailing wind direction, has been in force in certain localities for over a century. This procedure required little adaptation to convert it into one of successive regeneration fellings—that is, seeding, secondary, and final fellings—carried out in narrow strips running more or less at right angles to, and advancing progressively against, the prevailing wind direction. Hence, when the main object is protection against the wind, the regeneration of a compartment
begins with a seeding felling of the uniform type carried out over a narrow strip along the eastern or north-eastern edge of the compartment. As soon as regeneration on this strip is sufficiently advanced, a secondary felling is made over it, and a seeding felling is carried out along a second strip adjacent to the first one and on its windward side. When regeneration is sufficiently advanced on this second strip, it is subjected to secondary fellings and the first strip to further secondary or to final fellings, and a seeding felling is carried out along a third strip adjacent to the second one. In this way regeneration fellings advance progressively against the wind direction in a series of narrow strips. The progress of regeneration is represented diagrammatically in Fig. 37, while Figs. 38 and 39 show the appearance of strip fellings and regeneration.

In the shelter-wood strip system, as in the uniform system, the
FIG. 38. Shelter-wood strip system of Württemberg in forest of spruce, silver fir, and Scots pine. Strip felling on level ground proceeding from left to right (NE. to SW.) against the prevailing wind. Pfalzgrafenweiler, Black Forest. (Note. The logs seen in the picture are lying beside a road, and have not been felled into the young growth.)
Fig. 39. Shelter-wood strip system of Württemberg in forest of spruce and silver fir. Strip felling on hilly ground proceeding in a downhill direction and also against the prevailing wind. Regenerated area in foreground. Schönmünzach, Black Forest.
number and the frequency of regeneration fellings vary with species, locality, conditions for regeneration, and other factors; in practice the number of successive regeneration fellings is by no means constant over each strip, since regeneration may appear more readily in some places than in others, necessitating a more rapid opening of the canopy in the former case than in the latter. Thus the number of successive strips under regeneration at one time may vary, although theoretically there are generally three, in the seeding, secondary, and final stages respectively.

The strip in the seeding stage is generally well defined, but those in the later stages often merge into each other, and their limits are not so readily distinguishable. Even after the final felling is completed the regeneration of light-demanders may continue for a time on the cleared strip. As a rule regeneration proceeds more rapidly under the strip system than under the uniform system, owing partly to the effect of side light before the seeding felling is made, partly to the larger quantity of seed provided by the adjoining wood, and in some cases to the protective influence of the latter.

The regulation of mixtures is carried out on lines similar to those adopted for the uniform system. In mixed forests of spruce, silver fir, Scots pine, and beech, the shade-bearing silver fir and beech are regenerated first by a slight opening of the canopy, the spruce appears as the canopy is opened further, and Scots pine seed-bearers are retained for a time over the strips from which all the other species have been removed, in order to regenerate gaps. Sometimes the regeneration of shade-bearers is stimulated in advance of the regular strip fellings by opening the canopy slightly for some distance ahead of them, or even over the whole area to be regenerated, so that when the strip fellings are carried out the regeneration of the more light-demanding species may proceed rapidly.

**Form of Strips.** The breadth of the strips varies according to circumstances. In the Württemberg Black Forest, where this system is well exemplified, new strips about 20 to 30 yards in width, or occasionally more, are put under seeding fellings at one time, and the total width of the belt under regeneration, from the seeding to the final stage, averages about 75 yards, though the actual width varies greatly according to the progress of regeneration.

On level ground the strips, at all events in the earlier stages, are generally in the form of straight lines, and this is also the case on hill-slopes in so far as the configuration of the ground permits. As the strips advance they tend to become more irregular, owing to the fact that regeneration does not always establish itself evenly
throughout their length. The local configuration or the shape of the regeneration areas may require strips which are not straight lines. In order to present a longer front, and thus accelerate the regeneration of an area, the strips are sometimes given a wavy or serrate or step-like outline, which has the disadvantage of complicating the alignment of the strips and is not to be recommended if it can be avoided.

Alignment of Strips. The original idea underlying the adoption of the shelter-wood strip system was the necessity for working against the prevailing westerly wind, so that the newly exposed edges of mature woods should always be protected from it. Hence on fairly level ground the strips are laid out more or less at right angles to the wind direction, and advance in a westerly to south-westerly direction against it. The trees are always felled into the old wood, and the timber is dragged out through it and not through the young crop.

In hilly country there are two primary considerations in deciding on the arrangement of strips, (1) the local wind direction, since the trend of the valleys and the general configuration frequently divert the prevailing westerly winds or cause strong local winds, and (2) the question of avoiding damage to the young growth during the extraction of timber down the hill-sides. Requirements in these respects are met by first determining the local dangerous wind direction and then arranging the strips so that in the first place the wind may not strike against the exposed edges of the old woods, and in the second place timber may be extracted down the slopes to the nearest road without passing through any young crops.

In practice the strips are laid out either horizontally along the contours, or vertically up and down the slope, or at an inclination to the horizontal or vertical, according to the wind direction and other considerations. In the case of strips which are horizontal or slightly inclined to the horizontal, fellings begin at the top of the slope and advance in a downhill direction, so that timber descends through the old wood and not through the young crop (see Fig. 43). In the case of vertical strips or those moderately inclined to the vertical, the trees are felled into the old wood and the timber descends through it. Frequently horizontal and vertical strips are both found in the same locality, one or the other being adopted according to the wind direction; sometimes both are combined on the same slope, with the object of accelerating the regeneration of an area.

The necessity for affording protection against wind has led to
the preparation of special 'felling keys' as a guide to the alignment of strips and the felling direction on different aspects in hilly country. Fig. 40 shows such a felling key prepared in 1885 for the Neuassing forests, Bavaria.

In Central Europe one of the most dangerous local winds is that which sweeps over a plateau from the west and drops down the eastern slope flanking it. In the case of horizontal strips advancing

![Diagram](image)

**Fig. 40.** Shelter-wood strip system. Bavarian felling key, showing arrangement of strips on slopes of different aspects. Small arrows show felling direction; $\rightarrow$, wind direction.

from the top of the slope downwards, such a wind would strike the exposed edge of the wood, and hence on slopes swept by a descending wind of this kind it is customary to adopt vertical strips. The arrangement shown in Fig. 41 is adopted on the southern slopes of certain mountains in Austria to guard against the west wind as well as a wind descending from the mountain tops. Here the fellings in the lower sections of the slope proceed in advance of those in the sections above them, so that there is always a sheltering wood immediately on the uphill side of the exposed strips.

Hitherto we have considered the arrangement of strip fellings with special reference to protection against prevailing winds, for which purpose a felling direction from E. to W. or from NE. to
SW. is the rule in continental Europe. In recent years Dr. C. Wagner has demonstrated that wind is by no means the only factor to be reckoned with in the arrangement of strip fellings, and that there are other factors, and in particular the sun, which may exercise a profound influence on natural regeneration. He has shown that under certain conditions the adverse effect of the sun, in causing the desiccation of the soil and preventing regeneration, is so great that strip fellings ought to proceed not from E. to W. but from N. to S., in order that the strip under regeneration may receive the lateral

![Diagram of Shelter-wood strip system](image)

**Fig. 41.** Shelter-wood strip system. Arrangement of vertical strip fellings on a southern slope with the object of providing a safeguard against the west wind and also against a descending wind from the north. **\( \rightarrow \),** wind directions; small arrows show felling direction.

shade from the sun which is afforded by the old wood to the south of it. This question will be discussed in detail in the next section.

**Cutting Sections.** The rate at which strip fellings advance through an area depends mainly on the rapidity with which regeneration appears and establishes itself, and therefore varies greatly under different conditions. In the spruce and silver fir forests of Central Europe the average rate of advance ordinarily varies from under 2 yards to about 10 yards a year. Where the rate averages 2 yards a year it would take a whole rotation of 120 years to regenerate a compartment of 240 yards in length, and the crop would consist of a series of parallel even-aged strips from 1 to 120 years old arranged in regular succession from one end of the compartment to the other. This is a perfectly legitimate arrangement, and the idea is actually followed out in Wagner's *Blendersaumschlag*. But in the typical
form of shelter-wood strip system which was evolved out of the uniform system, even-aged crops and comparatively short regeneration periods—sometimes as short as 20 years—are aimed at. Hence it is necessary to divide the area to be regenerated into a number of

![Diagram](image)

**Fig. 42.** Shelter-wood strip system on level ground, showing three cutting sections with felling direction against the wind. *a*, *a*, old wood; *b*, *b*, seeding fellings; *c*, *c*, secondary fellings; *d*, *d*, final fellings; *e*, *e*, young regenerated crops; *f*, *f*, severance cuttings; *f*, felling direction; *w*, wind direction. Dotted arrows show direction of timber extraction.

![Diagram](image)

**Fig. 43.** Shelter-wood strip system on a hill-side, showing felling direction partly against the wind and partly downhill. Letters as in Fig. 42. Dotted lines represent contours; dotted arrows show direction of timber extraction.

cutting sections (cf. p. 7), each of such a length that the strip fellings will advance from one end of it to the other in the number of years representing the regeneration period. For this purpose it is necessary to fix the regeneration period, if only approximately, and to estimate the mean annual rate of advance of the strip fellings; the length of the cutting section will then be the product of the two. Thus if the regeneration period is taken to be 25 years and the
average rate of advance is estimated at 5 yards, the length of the cutting section will be 125 yards; if the area to be regenerated is 500 yards in length, therefore, it will be necessary to divide it into four cutting sections. The shorter the cutting sections, and the more rapid the advance of the strip fellings, the more even-aged will the young crop be. A slow rate of advance produces a steeper slope in the profile of the young crop than a rapid rate of advance.

Broad cutting sections, that is, long strips, are an advantage from more than one point of view. In the first place work is more concentrated, and therefore less complicated and costly, than it is where felling and extraction are scattered over numerous short strips. In the second place a broad cutting section with no great length can be regenerated in a shorter time than an equal area of considerable length with no great breadth; regeneration therefore need not be unduly hurried, a matter of importance if much supplementary artificial regeneration is to be avoided.

The formation of cutting sections on level and on hilly ground is illustrated in Figs. 42 and 43. In forming cutting sections, the risk of exposing unprotected woods to the prevailing wind should be avoided. For this reason roads and other permanent lines should be utilized as far as possible to separate the cutting sections. Where it is necessary to divide woods into two or more cutting sections, severance cuttings (see p. 8) should be made if the wood is still young enough for low-branching border trees to develop.

In the formation of cutting sections on hill-sides, horizontal or slightly inclined strips should be avoided unless there is a good system of contour roads at fairly frequent intervals, as shown in Fig. 43. Where there is a long slope without such roads, timber from the upper sections will have to pass through young crops in the lower ones. On such ground vertical strips are preferable if there is no suitable road system.

**Advantages and Disadvantages of System.** The following are the chief advantages and disadvantages of the shelter-wood strip system:

**Advantages:** 1. It provides side protection in a definite direction; in the original system as just described the protection is against the west wind, while in Wagner's Blendersaumschlag—a modification described in the next section, in which strip fellings proceed from N. to S.—the protection is against the sun; side protection is now generally recognized as being more effective than overhead cover in localities subject to frost and drought, and in this respect the advantage possessed by felling in strips is apparent.
2. Side light is utilized to the utmost, and complete overhead light is available at an early stage, since even sensitive species may be uncovered rapidly owing to the side protection afforded by the old wood; this admission of light stimulates the development of seedlings and is favourable to the regeneration of light-demanding species.

3. Damage to the young crop during felling and extraction is minimized owing to the fact that trees are felled into the old wood and timber is extracted through it.

4. Cultural and tending operations can be supervised easily, and the progress of regeneration can be followed without difficulty.

5. The progress of regeneration can be controlled readily in relation to the yield; where it tends to proceed too rapidly it may be retarded by decreasing the number of cutting sections or narrowing the strips, or it may be accelerated if desired by increasing the number of cutting sections or broadening the strips.

Disadvantages: 1. The fellings are scattered in many different places.

2. Storms occasionally come from unforeseen directions and may do much damage.

In practice the former objection scarcely holds, since fellings along the strips are fairly concentrated and the strips themselves are easily located.

Application of System. The shelter-wood strip system, as we have seen, was developed from the uniform system. Under the latter system the idea of beginning regeneration fellings in the E. or NE., and proceeding towards the W. or SW. against the prevailing wind, certainly existed in Germany in the beginning of the nineteenth century if not earlier. Cotta (Anweisung zum Waldbau, 1817), in describing the uniform system, says that where there is danger from storms the fellings should proceed from NE. to SW., particularly in the case of spruce woods. Even the division into cutting sections appears to have been recognized a century ago: Hundeshagen (1828), referring to spruce shelter-wood strip fellings proceeding from NE. to SW., states that in order to obtain the yield from such narrow coupes, many separate coupes are necessary. Subsequent German writers of the nineteenth century make frequent reference to strip fellings and to the employment of several lines of attack, meaning the division of the area into cutting sections.

In more recent times the shelter-wood strip system has been extended considerably, and in Württemberg in particular it has been greatly developed, having superseded the uniform system with a
short regeneration period; on this account it is sometimes termed the Württemberg strip system. Where reasonably short cuttings sections have been formed it has succeeded well, but the tendency has frequently been to form too large cutting sections, with the consequence that natural regeneration has been unable to keep pace with yield requirements, and much supplementary planting has been necessary. Until recently the felling direction in Württemberg has always been against the prevailing wind, that is, from E. to W. or from NE. to SW., but under Wagner’s influence this is being abandoned in some places for the N.–S. direction. There is also a tendency to make more use of advance growth than was the case formerly, and to adopt the strip and group system described later.

The shelter-wood strip system in one form or another—including Wagner’s Blendersaumschlag and the strip and group system—is much in favour at the present day, and the tendency in Central Europe is to extend its use in place of other systems. In France it has been tried to a very limited extent in the spruce and silver fir forests of the Jura.

3. WAGNER’S BLENDERSAUMSCHLAG

Definition and Terminology. Wagner’s Blendersaumschlag is a form of strip system in which the fellings are carried out in narrow shelter-wood strips extending in an E.–W. direction and advancing from N. to S., the object being to afford side protection against the sun to the seedlings on the strip under regeneration. The system was first elaborated in the forests of Count Pückler-Limpurg at Gaildorf in Württemberg by Dr. Wagner, ¹ who was in charge of these forests from 1898 to 1903. In the latter year he was succeeded by Forstmeister Rau, who has been largely responsible for carrying out Wagner’s ideas in practice. The Blendersaumschlag system was actually introduced in Gaildorf in 1902.

The term Blendersaumschlag has given rise to a great deal of misunderstanding as to the real nature of the system and the method of executing the fellings. This is probably due to the use of the word Blender (i.e. Plenter), which might be taken to imply selection fellings producing an uneven-aged type of crop (cf. under Selection System, p. 109). Consequently the Blendersaumschlag has been

¹ Dr. Christof Wagner, Professor of Forestry in the University of Freiburg, formerly Director of Forests in Württemberg. Full details regarding this system and its underlying ideas will be found in Dr. Wagner’s two books, Die Grundlagen der räumlichen Ordnung im Walde, 4th ed., 1923, and Der Blendersaumschlag und sein System, 2nd ed., 1915 (H. Laupp, Tübingen).
assumed to be a form of selection system in strips, producing uneven-aged crops, and has been rendered in English as ‘Strip Selection System’ or some other term of a similar kind. Actually the system as practised at Gailldorf is an even-aged one, in that it produces approximately even-aged crops over areas of appreciable extent, as will be apparent from the subsequent description of it. Wagner employs the term Blender to denote not fellings of the kind characteristic of the selection system, but fellings aiming at an uneven opening of the canopy (Blenderrieb) along the border strip; he does not insist on any one particular method of executing the fellings, but leaves this to be determined by local conditions. These somewhat elastic or selective shelter-wood fellings, which give rise to the term Blender, are of special importance in the regulation of mixtures. Since sporadic seed-bearers may be utilized in years of poor seeding, such fellings also facilitate regeneration.

Influence of lateral Shelter. Before going into the technique of Wagner’s Blendersaumschlag, it is necessary to appreciate its great underlying idea, namely the outstanding importance of the sun as a factor adverse to the establishment of natural regeneration under certain conditions. Wagner evolved his system after an extensive series of observations and experiments at Gailldorf, in mixed forests consisting chiefly of spruce, silver fir, beech, and Scots pine. The species on which he concentrated his attention more particularly was the spruce, the regeneration of which gave most trouble.

Following the accepted procedure of beginning strip fellings along the eastern and north-eastern edges of a wood and advancing them progressively towards the W. and SW., he observed that although spruce seed germinated well, the seedlings, owing to their shallow root-system, died of drought during the dry weather usually prevalent in June. On the other hand it was always in places sheltered against the south that regeneration was found to establish itself in quantity, while nowhere was there better regeneration or a better mixture of all species than in certain small gaps, made by storms and otherwise, along the NW. edge of the old crop. Following up the evidence thus collected, further observations were made along the edges of woods in all directions of the compass, and the factors operating on the various edges were studied in connexion with shelter-wood strip fellings. For this purpose it is convenient to divide the whole strip under regeneration into two portions, the inner strip, comprising the portion opened out for regeneration, on which a part of the overwood still remains, and the outer strip, that on which all the overwood has been felled but which receives some
side protection from the trees standing on the inner strip; thus the inner strip receives overhead as well as side protection while the outer strip receives side protection only. The following, according to Wagner’s observations, are the chief factors operating on the different edges of a wood, in their relation to natural regeneration:

Wind: a powerful desiccating agent if unaccompanied by rain, and in this condition inimical to regeneration. Dry winds are most prevalent from the east.

Rain is of two kinds: (1) more or less perpendicular rain which soaks the ground, and (2) light rain which is almost always brought by the west wind, falling in a slanting direction. This light rain does not as a rule drench the ground, but only wets the upper layers; it occurs chiefly in the dry seasons, spring and summer, and is of importance for shallow-rooted species. Ordinarily this rain is too light to pierce the canopy to any extent.

Dew is an important factor: it remains longest on the north edge of a wood and helps to prevent mortality among seedlings through desiccation.

Frost is a very harmful factor, and does most damage in places exposed to the morning sun.

Snow is a beneficial factor in (1) protecting seedlings from damage by deer, (2) keeping the ground cool and causing later sprouting and thus lessening the risk of damage by late frost, and (3) moistening the ground thoroughly. Snow, blown chiefly by the SW. winds, lies deepest on the lee of the N. and NE. edges; here it is not subject to alternate freezing and thawing as on the S. side, and hence on northerly edges there is less risk of damage by ice.

Sun is a most noxious agent, drying up the soil and causing high mortality among seedlings.

Now since agencies which bring moisture to the soil may be regarded as generally favourable to regeneration and those which have a desiccating effect on it are unfavourable, the following conclusions may be arrived at regarding the different points of the compass in their relation to regeneration by means of strip fellings.

E., SE., and S. These sides of a wood are altogether unfavourable. On the E. the morning sun penetrates even into the inner strip, and no light west rain gains admission to it; conditions are thus unfavourable both in the inner and in the outer strip. The night dew is at once dried up by the morning sun, while there is much danger from frost through the rapid thawing of frozen shoots.

S. to SW. Almost as unfavourable as the preceding, except that the action of the dry east wind and of the morning sun in its relation
to frost damage do not come into play: the SW. side benefits by the light west rain, it is true, but it also receives the full effect of the afternoon sun.

W. Rather more favourable. The midday sun does not penetrate to the inner strip, while the light west rain penetrates freely: the afternoon sun, however, is unfavourable.

NW. and N. The NW. is the most favourable side of all: here there is free admission of the light west rain into the outer and inner strips, complete protection from the midday sun and the dry east winds, and partial protection from the west wind. The beneficial influences of snow also come into full play. The N. is slightly less favourable than the NW., since the light west rain falls only on the outer strip; there is, however, protection from the morning as well as the afternoon sun, while some light rain beats in from the NW. On the NW. regeneration, especially of shade-bearers, appears even in the inner strip: on the N. it appears chiefly on the outer strip. Both on the N. and on the NW., conditions are particularly favourable for the formation of dew. The ground and the vegetation are not warmed by the sun, and hence the formation of dew commences with the exit of the damp air from the interior of the crop early in the evening and continues till the morning. The dew is thus heavier than on other aspects, while, being sheltered from the sun, it remains longer on the ground during the day.

NE. Sheltered from the midday sun but not from the morning sun, which dries up the night dew and adversely affects regeneration in frosty weather; does not receive the light west rain either on the inner or on the outer strip. This side of a wood has the advantage of shade from the sun all day except in the morning, but this is counterbalanced by dry easterly and north-easterly winds.

To summarize these conclusions, the NW. and N. sides of a wood, and particularly the former, are most favourable to regeneration, the NE. coming next: other sides are unfavourable, E. to S. being decidedly sterile. Wagner therefore decides that the ideal direction in which strip fellings should proceed is from NW. to SE., but where there is danger from wind it is necessary to alter the direction to one of N. to S.

In steep hilly country there are exceptions to the general rule. The winds bringing rain are as a rule diverted from their course and blow along the slopes. The effect of the sun is strengthened or weakened according to the angle at which it strikes the surface of the ground: thus on S., SE., and SW. slopes the sun exercises a much more adverse influence than on N., NE., and NW. slopes.
STRIP SYSTEMS

It should be remembered that Wagner's observations and conclusions have special reference to Gaidorf, where the forests are situated at elevations between 1,000 and 2,000 feet on Middle Permian marly sandstone; the normal rainfall is about 30 inches, and there are occasional periods of long drought in the spring which are particularly unfavourable to spruce seedlings with their shallow root-systems. Under such conditions protection from the desiccating action of the sun might well be expected to be an important condition for successful regeneration; in drier climates it would be an even more essential condition. Wagner's conclusions are by no means applicable to Gaidorf alone; they have been fully confirmed in many other regions where the desiccation of the soil is a factor to be reckoned with, and Wagner's strip system is now successfully applied in many parts of Central Europe.

Evidence of the value of side protection from the sun is by no means confined to Europe. Various observations made by the writer in the Himalayas have shown that on dry slopes natural regeneration of deodar (Cedrus Deodara) and spruce (Picea Morinda), and even of the drought-resisting Pinus longifolia, is greatly favoured by lateral protection from the sun.

On the other hand, even in the case of the European spruce, at the higher elevations with abundant rainfall and a cool climate, protection from the sun may be not only unnecessary but even harmful. Thus in certain parts of the Böhmerwald, in South Bohemia, where much moister conditions prevail than at Gaidorf, strip fellings from N. to S. have failed owing to excessive damp and rank weed-growth. In the forests of Kamenitz in South Bohemia, where Blendersaumschlag fellings from N. to S. are practised with success, it is found preferable in moist situations to carry out fellings from S. to N. In the forest of the Sihlwald in Switzerland, fellings advancing from S. to N. give results as good as those advancing from N. to S. In the forest of Eschenberg near Winterthur strip fellings advancing from S. to N. are considered preferable even to those advancing from N. to S., since warmth and abundance of side light are considered to be of more importance than protection against the sun. In northern latitudes, where there is a long and intensely cold winter and a short growing season, it is not improbable that fellings from S. to N. may be found most favourable to regeneration. Soil moisture has less effect on the regeneration of broad-leaved species than of conifers, for which reason, according to Bühler, some of the older writers make the proposal that fellings in broad-leaved woods should proceed from S. to N.
As regards Scots pine, Dr. Wiedemann, in an article\(^1\) which summarizes the experience of other writers as well as the results of his own investigations in Saxony and in other parts of Germany, comes to the conclusion that side shade does not help the growth of the young plants but rather in many cases hinders it, sometimes permanently. In the cases which came under notice, the adverse effects of side shade extended in nearly every case to 3–8 metres and often to 15 metres from the old wood, the injury being greatest in fellings from N. to S. or from NE. to SW., that is, where the sun was kept off. On other exposures most of the harm was done by drip and root competition. The adverse effects of side shade from the sun were not very pronounced on dry ground with little grass, but in moister situations, especially on fertile grass-covered ground, many plants were found to die off in the first year, while many succumbed in the earlier years to needle-cast (*Lophodermium Pinastri*).

From the general point of view, therefore, the great value of Wagner’s work lies not only in demonstrating the necessity, under certain conditions, for maintaining side protection against the sun, but even more in drawing attention to the importance of studying the various factors operating on different edges of a wood, with the view of determining if any of the edges are specially favourable to regeneration or the reverse, and arranging the felling direction accordingly. The principle of working to the compass, to which Wagner has drawn attention, is one which is likely to have far-reaching application not only in temperate but also in tropical countries.

Records show that the advantages of side protection from the sun, so well demonstrated by Wagner, were appreciated to some extent even in the early part of last century. Zötl, writing in 1831 with special reference to the Tyrol, says that coupes should be so arranged that the chief injurious factors, strong sun and wind, should be guarded against.

In the highlands of Swabia in Bavaria strip fellings from N. to S. were in operation before the middle of last century. This tract, lying at an elevation of some 1,600 to 2,000 feet above sea-level, has a mean rainfall varying from 25 to 30 inches, and the forests are situated for the most part on coarse-grained permeable sands, hard sandstones, quartzites, and crystalline rocks. In the working plan of Oberkammlach, 1843, narrow strip fellings advancing from N. to S. are prescribed for spruce, the object being to provide side shelter from the sun. In the working plan of Franken-

\(^1\) *Zeitschrift für Forst- und Jagdwesen*, June 1926, p. 333.
hofen-Sachsenried, 1844, the advantage of side protection from the
sun is definitely stated in the following words (translation): 'In
view of the unfavourable influence of the southern exposure on
spruce and beech regeneration, through the prolonged heat of the
sun . . . the fellings in future should proceed not from E. to W., but
rather from NE. to SW. or NNE. to SSW., and where local condi-
tions permit or demand it, even from N. to S., since experience
hitherto has shown that by such a felling direction the young growth
and the soil receive more protection and shelter owing to the pres-
ence of the adjacent stand, and natural regeneration is particularly
successful.'

The procedure in force for some of the spruce forests of South
Bavaria about the middle of last century was to make seeding fellings
in long narrow strips advancing from NNE. to SSW. or from N. to S.;
secondary fellings were carried out 4–6 years and final fellings 6–8
years after the seeding fellings.¹

**Basis of System.** Wagner does not claim any rigid distinguishing
features for his system save in two respects, (1) the form of the
coupe, which should be a long narrow strip, and (2) the compass
bearing of the coupe, that is, it should extend from E. to W. in
order to secure the advantages of side protection from the sun.
Even these two features are not strictly unalterable, and are subject
to modification under special circumstances. All other conditions,
such as the nature of the fellings, the interval between them, and
the rate at which they advance, are freely alterable to suit individual
cases.

In evolving this system, Wagner has been guided by certain
considerations which he regards as of fundamental importance in
respect of systems in general. Among these are (1) the desirability of
securing mixed crops by means of natural regeneration, and avoiding
pure crops and artificial regeneration, (2) the avoidance of extensive
clearings, (3) the advantage of bringing trees up in even-aged form
in relation to those immediately round them, in order to secure
a good shape of bole and an even structure of timber, (4) a definite
area separation of the age-classes, and the felling of trees away from
young growth, with the object of avoiding damage, (5) the question
of securing close supervision and easy control.

By adopting a system of strip fellings Wagner claims to have
secured these advantages, and above all he regards the felling
direction from N. to S. as the chief factor in securing natural
regeneration of the desired species.

¹ *Allgemeine Forst- und Jagd-Zeitung*, 1853, p. 203.
Conduct of Fellings. In Wagner's *Blendersaumschlag* the regeneration fellings are carried out as in the case of the shelter-wood strip system (p. 79), with the important difference that fellings proceed from N. to S. instead of from E. to W. At Gaildorf the strips are laid out with mathematical exactness with the aid of a compass, in lines running due E. and W.; this rule is departed from only in special cases. The regeneration of an area generally begins with the felling of a narrow clear strip along the northern edge of the wood in a good seed-year, and where there is any risk of a heavy growth of grass this strip is at once planted up; at the same time a seeding felling is carried out in the next strip, which is broader. The object of the initial clear strip is to ensure the prompt beginning of regeneration; if the border trees are left in part, their well-developed root-systems tend to hinder the establishment of seedlings.

Seeding, secondary, and final fellings follow each other as in the shelter-wood strip system in general, and mixtures are regulated as already described (p. 81). At Gaildorf great care has to be taken to keep the canopy dense until the moment the seeding felling is carried out, in order to prevent the premature regeneration of shade-bearers, and particularly beech, which tends to usurp the ground to the exclusion of other species; for the same reason, as soon as beech regeneration appears the canopy has to be opened out further in order to admit other species, the young beech being removed if necessary where it is too plentiful. There is no definite rule as to the breadth of each strip; in general, however, Wagner's system involves narrow strips up to about half-tree height or little more. Advance growth is usually cut out at the time of the seeding felling, only promising groups of advance growth, in gaps caused by wind or snow, being left.

Once begun, the strip fellings should advance steadily and without any hiatus; too great a difference in age between the plants on successive strips tends to promote branch-formation, which is undesirable. The progress of the strip fellings varies considerably, and may be hastened or retarded in order to comply with yield requirements and to follow the progress of regeneration. At Gaildorf the average rate of advance in different sections varies from about 1 metre or even less to as much as 10 metres a year, the resulting crop being more even-aged in the latter case than in the former. Where the rate of progress is too slow it may be hastened by increasing the breadth of the strip in which seeding fellings are carried out, and if necessary by hoeing the soil and even by artificial regeneration, preferably in the form of sowing. The number and
the frequency of the regeneration fellings are not absolutely fixed; theoretically there are three successive fellings repeated on the same strip on an average every 3 years. In good seed-years the seeding fellings are pushed on, while in poor seed-years secondary or final fellings are carried out. The aspect of the strip fellings is shown in Figs. 44 to 47, and Fig. 47 shows the method of felling into the old wood in order to avoid damaging the young crop. These illustrations, which are typical, show that the young crops produced are of an even-aged type over appreciable distances, particularly where the rate of progress has been rapid; they are

![Diagram](image)

**Fig. 48.** Wagner's **Blendersaumschlag.** Step fellings advancing from N. to S. giving protection against both sun and wind. \( f \), felling direction; \( w \), wind direction; \( o \), old wood; \( r \), regenerated area.

in no sense of the term crops of the selection type, as is sometimes imagined.

Where necessary, protection against the west wind can be secured, while still maintaining lateral shelter from the south, by working in echelon formation as shown in Fig. 48. An example of this formation, termed **Staffelschlag** or **Treppenhieb** (step felling), may be seen in Fig. 44. Where conditions render it desirable that the fellings should advance in a direction between S. and W., narrow openings are made like the teeth of a saw, and the strips advance diagonally in a more or less south-westerly direction, as shown in Fig. 49 (**Buchtenhieb** or bay felling).

In hilly country the direction of the strip fellings has to be arranged in such a way as to provide protection against the sun as well as the wind, and to allow for the extraction of timber down the slopes without passing through regenerated crops. As in the ordinary shelter-wood strip system, this implies a good road system. A simple felling key on the Bavarian pattern, illustrated in Wagner's **Grundlagen**, is shown in Fig. 50; this resembles in some respects
FIG. 44. Wagner’s Blenderaumschlag in forest of spruce, silver fir, and beech. Strip fellings proceeding towards left (south). Regenerated area on right represents average rate of advance of 7 yards a year. Gaildorf, Württemberg.

FIG. 45. The same. Strip fellings proceeding up slope towards right (south). Road forms boundary of cutting section; area on right of road regenerated in 12 years. Gaildorf, Württemberg.
Fig. 46. Wagner’s Blendersaumschlag in forest of spruce, silver fir, and beech. View northwards through strip under regeneration across regenerated area to adjoining cutting section. Regenerated area represents progress of 80 yards in 15 years. Note beech regeneration in foreground. Gaildorf, Württemberg.

Fig. 47. The same. View along strip under regeneration, showing method of felling into old wood to avoid damage to young crop. Fellings advancing towards left (south). Gaildorf, Württemberg.
the key illustrated in Fig. 40. A more elaborate felling key is shown in Fig. 20 of *Der Blendersaumschlag und sein System*, 2nd ed., 1915.

In practice, horizontal strip fellings proceeding downhill from S. to N. are sometimes employed on steep shady northern slopes where the soil is sufficiently moist to ensure the survival of seedlings. The forests of Gaidolf are situated on rolling country without any large or steep hills, and the N.–S. direction can be maintained everywhere without difficulty, the fellings advancing uphill where necessary (see Fig. 45).

**Form of Crop produced.** In the general account of the shelter-wood strip system we have seen that, since it was evolved out of the uni-

![Diagram](image)

**Fig. 49. Wagner's Blendersaumschlag.** Fellings advancing diagonally towards WSW. *f*; felling direction; *w*, wind direction; *o*, old wood; *r*, regenerated area.

form system, the idea of obtaining more or less even-aged crops over whole compartments has been perpetuated, and in order to effect this object small cutting sections are formed and strip fellings proceed simultaneously through each (see p. 84, and Fig. 42). Wagner’s *Blendersaumschlag* has a different object in view: it aims not at even-aged crops over considerable areas, but at uneven-aged crops. In this system the crop is even-aged along the direction of the strip (E. to W.) but uneven-aged from one end of the regeneration area to the other (N. to S.). The ideal form of crop in a single unit is one containing trees of all ages from 1 to *r* (the rotation) arranged in successive strips; in practice such complete units seldom exist, though the more age-classes these units contain, and the shorter they are, the more favourable they are considered to be from a silvicultural point of view. The only exception is on southern slopes and sometimes on steep northern slopes, where horizontal strip fellings advance downhill; here long slopes should be divided into sections by contour roads in order to avoid dragging timber.
down through young crops, and the time taken to regenerate a section should not be more than 40 years.

Each unit containing an ascending series of age-gradations from the seedling upwards is called a Schlagreihe, for which the English term 'felling unit' may be employed. The Schlagreihe is defined as

![Diagram](Fig. 50. Wagner's Blendersaumschlag. Felling key on the Bavarian pattern, showing arrangement of strips on different slopes with the view of protection against sun and wind. Small arrows show felling direction; w. wind direction. (After Wagner.)]

the area between two lines of attack (i.e. strips under regeneration) and is movable, since the strips must be proceeding continuously forward: in Wagner’s words, ‘the Schlagreihen follow each other like the waves of the sea’. These felling units, and the ideal form of crop produced by the Blendersaumschlag, can best be appreciated from Fig. 51. This form of crop Wagner terms geordneter Blendervald (organized selection forest), that is, forest containing trees of all ages, like selection forest, but with this important difference, that the age-classes, instead of being mixed together, are regularly
distributed in succession from one end of the area to the other. This arrangement possesses various advantages over the typical Blenderbetrieb or selection system: the age-classes can be readily distinguished from each other (an important point in determining the possibility), the progress of regeneration can be more easily watched and controlled, fellings can be easily located and supervised, and damage by felling and extraction is reduced to a minimum.

Although the ideal young crop aimed at is one with a sloping canopy, such as would be produced by a slow rate of progress, actually at Gaildorf the characteristic picture is that of fairly even-aged young crops rather than of steep-sloping canopies, since the rate of progress is affected by such questions as the yield and the

Fig. 51. Profile of a portion of an organized Blendersaumschlag forest, showing three felling units. Felling direction from N. to S. (Vertical scale about 10 times horizontal scale.)

necessity for opening the canopy sufficiently rapidly to maintain a mixture of light-demanding species.

The Blendersaumschlag idea of producing crops consisting of a series of ascending age-classes in regular succession by means of narrow progressive shelter strips is to be found in the older Saumfemelbetrieb of Oberforstmeister Ney, who introduced the system in order to avoid the damage done under the usual selection system by felling large trees over smaller ones. He divided the whole forest into blocks, in each of which all age classes were to be represented, not mixed together as in the selection system, but separated in parallel progressive strips, so that fellings should begin at one end of a block and proceed progressively through it. Ney, however, does not appear to have regarded the sun as a determining factor in regard to the direction of fellings, since he proposed as an alternative to his Saumfemelbetrieb a method which he termed Ringfemelbetrieb, under which regeneration should proceed not from one end of a block to the other but from the centre outwards in a series of concentric circles. This would doubtless have obviated the felling of large trees over smaller ones, but it would have exposed the gradually widening gap to the effects of both sun and wind. It would have also made any adjustment between the rate of regeneration and the
outturn of timber difficult, if not impossible, since the outturn would
tend to increase steadily as the gap widened and the length of the
circular strip under regeneration became greater and greater.

**Cutting Sections.** In describing the *Blendersaumschlag* Wagner
uses the term *Hiebszug* (cutting section) in the sense of a permanent
definitely bounded area, a unit of management. Taking the term
in this sense, the ideal cutting section of the *Blendersaumschlag* is
a complete series of age gradations, in which case it is synonymous
with a felling unit (*Hiebsreihe*), but actually it may contain two or
more felling units. It should be surrounded by roads and bordered
on the S. and W. by shelter-belts, preferably of wind-firm broad-
leaved species, of which oak is the best. In hilly country the bound-
daries of cutting sections should be along the ridges and down the
spurs, not down the ravines separating the spurs.

In laying out cutting sections for the first time, one or more
felling units extending right across them from E. to W. should be
formed in such a way that as far as possible the older crops are
placed in the northern part of each felling unit and the younger
crops in the southern part, the general sequence of age-classes
descending from N. to S. Otherwise the length of each felling unit
is determined according to the probable progress of natural re-
regeneration. It is a good maxim to keep the number of felling units
in a cutting section down to a minimum, as this facilitates super-
vision; in other words, the number of age-classes represented in the
ideal felling unit should be the largest possible.

Cutting sections and compartments should coincide as far as
possible, and in laying out a new area the former should be deter-
mined first and the latter then made to conform to them. Where
well-defined compartments already exist, cutting sections should,
as far as is practicable, be made to coincide with them. The usual
size of a cutting section may be taken to be about 30 to 50 acres.
At Gaßeldorf the most suitable length for a felling unit is considered
to be 300 metres, and this is perhaps a better criterion than area.

**Application of System.** The principles enunciated by Wagner,
particularly in regard to the adverse effects of the sun, and the
advantages of felling in narrow strips from N. to S., have had a
profound effect on European forestry during the past decade or two,
particularly in Central European countries, where *Blendersaum-
schlag* principles in one form or another have been applied in many
different localities, sometimes, it must be admitted, with insufficient
reason. The system is not always applied in the ideal form described
by Wagner, almost any form of strip or strip and group felling
from N. to S. being designated Blendersaumschlag. Often small cutting sections on the Württemberg plan are formed with the object of regenerating whole compartments in a limited period of years. A modification of the system has proved successful in the Scots pine and spruce forests of Finspong, Sweden. As has already been pointed out, the idea of working to the compass is one which is capable of wide application, and it may yet be the means of solving problems of regeneration in many parts of the world.

4. THE STRIP AND GROUP SYSTEM

General Description. The strip and group system is a modification of the shelter-wood strip system, and bears the same relation to it that the group system bears to the uniform system. The German term is Saumfemelschlag, and the system is sometimes alluded to as the Bavarian Saumfemelschlag or Von Huber’s method, from the fact that in the first instance it was developed chiefly in Bavaria, by Von Huber. The general scheme of cutting sections and strips is the same as that of the shelter-wood strip system, but the fellings are carried out in a different manner. In the initial strip a seeding felling is carried out consisting of an even opening of the canopy in the usual way together with the freeing of any groups of advance growth in gaps caused by wind or snow. At the same time further groups of advance growth are sought for and freed for some distance ahead of the initial strip, while if necessary further gaps are created artificially in order to induce more groups of advance growth to appear; these groups of advance growth are enlarged from time to time as in the group system. Meanwhile the strip fellings advance steadily, absorbing the groups of advance growth, and new gap fellings are also pushed on some distance ahead of the strip fellings, until the end of the working section is reached. Fig. 52 shows diagrammatically the progress of fellings under the strip and group system. In some cases group fellings are made all over a cutting section before the strip fellings are begun, and the latter are largely in the nature of removal fellings. The progress of the fellings, and the form of the strips, is less regular under this system than under the shelter-wood strip system, as may be seen from Fig. 53.

The strip and group system is well adapted for the regulation of mixtures, on the lines already indicated for the group system (pp. 66–8). Shade-bearers may be introduced artificially in small gaps ahead of the strip fellings; beech is frequently introduced in this way into coniferous forests, the conifers being afterwards re-
generated naturally by strip fellings. Seed-bearers of light-demanding species are generally retained on the strips until the final felling, in order to seed up gaps, or such species may be introduced artificially on the strips when they have been opened out.

The strip and group system is widely practised in various parts of Central Europe, particularly in Austria, Czechoslovakia, and Bavaria, as well as in parts of Baden and Württemberg. A modification of the strip and group system is practised in Switzerland and to some extent in Baden, strip fellings being carried out in conjunc-

![Diagram](image)

**Fig. 52.** Strip and group system, showing progress of felling against the wind. Regenerated areas in black. $f$, felling direction; $w$, wind direction.

...tion with the Swiss or Baden *Femelschlag* system. The procedure is to bring regeneration to an advanced stage by irregular shelter-wood fellings for some distance ahead of the strip fellings, and to employ the latter for the final removal of the remaining seed-bearers; by this means the regeneration of light-demanders like Scots pine and larch can be accomplished by retaining seed-bearers of these species for a time on the strips. Fig. 54 shows the appearance of a strip felling of this kind.

**Comparison with Shelter-wood Strip System.** The strip and group system possesses certain advantages over the typical shelter-wood strip system similar to those possessed by the group over the uniform system. Regeneration can be accomplished with greater certainty and rapidity owing to the establishment of groups of advance growth ahead of the strip fellings, and the uneven-aged
form of the young crop serves to some extent as a protection against snow and wind. Mixtures can also be regulated more easily. On the other hand there is considerable risk of damage to the groups of advance growth during the extraction of timber, particularly on steep slopes.

5. THE PROGRESSIVE CLEAR-STRIP SYSTEM

A clear-strip felling in the sense in which it is used in this section is a clear-felling in the form of a strip so narrow that the adjoining old wood, through the lateral shade or protection afforded by it, exercises a direct influence on the strip and may thus produce a marked effect on the survival of seedlings and the establishment of regeneration, whether natural or artificial. The width of a strip of this kind generally varies from half the height to the full height of the trees of the old wood. Such a strip should have the full advantage of the favourable influence of the adjoining old wood, otherwise the felling ranks as a strip-like clear felling.

The German term for such a narrow clear-strip felling is Kahl-saumschlag, in contradistinction to Kahlstreifenschlag, which denotes the felling of a clear strip (Streif) of some breadth.

Generally speaking, clear-strip fellings are employed in order to secure the advantages of side protection from the sun where this is found to be beneficial, and the strips advance in a general N.–S. direction. The arrangement of cutting sections and fellings is similar to that of the shelter-wood strip system or Wagner’s Blender-saumschlag, except that the strips are clear-felled and regenerated naturally from the adjoining old wood, or if necessary artificially; the next strip is not felled until the regeneration of the previous one is established. Dr. Wiedemann’s investigations mentioned on p. 93 tend to show that narrow strip fellings from N. to S., with intervals of some years between adjacent coupes, are not always suitable for Scots pine.

The progressive clear-strip system arose out of the progressive clear-cutting system with natural regeneration from adjoining woods. This latter system, with long narrow coupes and a felling direction against the wind, is a very old one and was at one time much in use, but the idea of employing narrow strips for protection against the sun is a later development. The progressive clear-strip system is employed chiefly for spruce and Scots pine, and may still be seen in certain places in Bohemia and other parts of Central Europe, with artificial or natural regeneration. Where natural regeneration is relied on it is far less commonly practised at the present day than
the shelter-wood strip system, owing to the greater risk of failure in regeneration and of soil deterioration and weed-growth.

6. THE ALTERNATE CLEAR-STRIP SYSTEM

Fellings in alternate clear strips are known in French as Coupes par bandes alternes, in German as Kulissenhiebe, Springschläge, or Wechselschläge. In its usual form the alternate clear-strip system consists of cutting parallel clear strips through the forest, usually up to 100 feet wide, leaving intervening untouched belts of equal width between these strips. The clear strips are regenerated artificially, and the young crops benefit from the lateral protection of these belts. When the young crops on the regenerated strips are fully established and out of danger from frost or drought, the intervening belts are felled and regenerated artificially. This system is employed to some extent as a protection against late frosts on the Rhine–Main plain in Germany. Its chief use is for the introduction of tender species in mixture with existing species, strips being generally more convenient than groups for this purpose.

A less common method is to allow the young crop, established on the clear strips by artificial or natural regeneration, to grow up until it is high enough to afford lateral protection in its turn, when the intervening belts of old wood are felled and regenerated. This procedure has not found much favour, and has been generally abandoned in Europe. Although effective from the point of view of protection, it is somewhat difficult to work in practice owing to the long lapse of time—40 to 50 years or more—between the two fellings, and the consequent difficulty of keeping trace of the strips. Along the edges of the old strips, again, the young plants tend to become suppressed and to die off, particularly in the case of light-demanders.

Alternate clear-strip fellings have been practised in Germany for a long time. They are referred to, among other methods, in the Hesse-Kassel Ordinance of 1761, and many writers of the nineteenth century mention them. They appear to have been more in use at one time than they are at present.
Fig. 53. Strip and group system in forest of spruce and silver fir. Fellings proceeding from left to right downhill and against the prevailing wind direction. Schiffrschafswald, Baden Black Forest.

Fig. 54. Strip felling in combination with Swiss Femelschlag system in forest of spruce, silver fir, and beech. Fellings proceeding from right to left. Eschenberg forest, Winterthur, Switzerland.