V. Application of PFT in Cash Crop Cultivation

Sugarcane

Application of PF in sugarcane cultivation in China started very late, but its development took place rapidly. The first experiment was carried out in Guangdong Province in 1980, and, up to 1982, the area of sugarcane cultivated under PF was only 200 hectares throughout the whole county. Since then, this technology has become popular in Guangdong, Guangxi, Hunan, Zhejiang, Sichuan, and Yunnan, and the total area cultivated with PF had reached 8,660 hectares in 1984. As cultivating sugarcane under PF yielded better results than open land cultivation, farmers considered it to be an effective measure of increasing yields. In 1985, the area of sugarcane cultivated by using PF reached 8,000 hectares in Guangdong Province.

Effects of PF on Sugarcane Cultivation

Prolonging the Growth Period of Sugarcane. Usually, the sprouts of sugarcane emerge at 13°C and the leaves grow at 15°C. But, in some areas of cultivation, for example, in Guangdong, the air temperature in winter is always below from 13°C to 15°C, and the weather is also very dry. Under these conditions, the sprouts emerge very slowly, the period of sprouting is very long, and the percentage of sprouting is very low. Since PF increases the soil temperature and retains moisture, the sprouting and growth of sugarcane are greatly improved.

According to research carried out in Yiwu county, Zhejiang Province, as the temperature of the air under the PF increases by six to seven degrees centigrade, the sprouts emerge 20 days earlier than normal, the rate of sprouting increases by 20 to 30 per cent, the rate of stooling increases by 100 to 200 per cent, and thus the yield of sugarcane increases by 28 to 42 per cent over sugarcane cultivated by normal methods. In Hunan Province, it was discovered that PF is very useful for overcoming the problems of low temperatures and of overcast rainy weather which cause late sprouting, low sprouting rates, and non-emergence, of plants. PF can also help decrease the damage caused by early frost in the late period of growth. As a result of prolongation in the period of growth, sugarcane can absorb the abundant heat and sunshine in June, July, August, and September, thus increasing the yield of sugarcane. The longer the period of growth, the higher the yield.

Increasing the Yield of Stubble Sugarcane. When stubble sugarcane is cultivated on open land, a number of the buds on the stools of the sugarcane die during the winter. According to research carried out by Guangxi Agricultural College, after stubble sugarcane was covered with PF, the rate of dead buds decreased from 42 per cent to 19 per cent. These buds neither die nor sprout before reaching the stage when sprouts appear. In this case, the total number of buds that sprout would be doubled if PF was used. As the buds sprout early, quickly, and evenly, the available stems (or canes) increase and the weight of a single stem (or cane) would also increase.

The Agricultural School of Dongguan County, Guangdong Province, carried out experiments over a period of two years on the use of PF to cultivate stubble sugarcane. The results showed that the yields of sugarcane covered with PF reached

105,442.5kg per hectare, compared to yields from sugarcane cultivated on a field without PF (37,055.0kg per hectare); PF increased the yield by 36.8 per cent. In addition, the content of sugar in the canes covered with PF reached 15.15 per cent and that in those cultivated without PF reached 13.57 per cent. This means that PF increased the content of sugar by 1.58 per cent.

Cultivating Sugarcane with PF

Operative Technology for Newly-planted Sugarcane Fields. PF is suitable for sugarcane planted in late autumn, after the rice harvest, and in winter and early spring.

i) *Decontamination and Forced Sprouting.* Because of the high humidity caused by PF, diseases are easily spread. Before layering the seed canes, they should be soaked in two per cent of lime solution for 24 hours in order to decontaminate the canes and promote water absorption. Then the decontaminated cane sections should be piled from 33 to 66cm high on the wet rice straw, sufficient water should be poured on the cane sections, and the cane sections should be covered with earth. Finally spread PF on the piles. After 10 to 15 days, the sprouts emerge. Under the PF, due to high temperature and high humidity, the rate of sprouting increases so that the layering quantity of cane sections decrease by 10 to 20 per cent compared to the layering quantity on open sugarcane fields.

ii) *Application of Sufficient Basic Fertiliser.* As it is difficult to apply additional fertiliser after spreading PF, it is necessary to apply sufficient basic fertiliser. Since the temperature of the soil is high under the PF, the organic matter decomposes quickly, and it is better to apply more manure. Each hectare requires 22,500 to 37,500kg of miscellaneous manure; 375 to 750kg of calcium superphosphate; 187.5 to 450kg of potassium chloride; and 187.5 to 450kg of urea.

iii) *Sufficient Irrigation.* Before layering the cane sections, the furrows should be irrigated, the mud stirred, and the cane sections should be inserted into the mud (about half of the length of the cane section). After that, the furrows should be irrigated again. This irrigation ensures that the cane sections absorb enough water after sprouting. After the water has been absorbed into the soil, spread a thin layer of soil on the cane sections, and then cover them with PF. In those areas where there are no irrigation facilities, the rush-planting (quick planting) after rainfall is adopted. In this case, preparing the ground, applying basic fertiliser, and making furrows should be carried out in advance. When the field is saturated with rain, rush-plant the cane sections immediately and cover them with PF. This measure can satisfy the minimum water requirements of sugarcane when they are in the seedling stage. When monsoon begins, water supply is no longer a problem.

iv) *Controlling the Weeds.* Under the PF, high temperature and high humidity promote the growth of weeds so application of weedkillers is necessary. In Guangdong Province, in sugarcane fields without intercropping, 2.63kg per hectare of simazine or ametryn is sprayed; in fields with intercrops, such as peanuts and beans, if the dominant

weeds are monocotyledons, three kilogrammes per hectare is sprayed; if the dominant weeds are both monocotyledons and dicotyledons, a solution of 100 grammes of Machete (butachlor) plus 50 to 60kg of water, or a solution of 100 grammes Lasso (alachlor) plus 150 grammes of Roundup (glyphosate) and 50 to 60kg water is sprayed. In Hunan Province, usually a solution of 100 grammes of MCPA-sodium, 250 grammes of Nitrofen, and 30 to 35kg of water, or 400 grammes of Diuron and 30 to 35kg of water is sprayed.

v) *Spreading PF.* When the cane sections are planted in one row, the width of PF should be from 45 to 50cm and the required amount is from 45 to 52.5kg per hectare. As PF is relatively narrow, it should be carefully spread so that light can permeate the pervious area and so that the effect of temperature increase is enhanced. This method can save the amount of PF and reduce the cost of spreading. When the cane sections are planted in double rows, the width of PF should be from 160 to 180cm. This method permits light to permeate the pervious area, effectively increases temperature, and maintains moisture. In fact, the rate of sprouting, the amount of stooling, and the leaf area index under wide PF are higher than under narrow PF, but, under wide PF, when the sprouts emerge, young leaves will scorch, because of high temperatures and strong light. It is necessary to remove them from the PF on time. When the sprouted cane sections account for more than 80 per cent of the total cane sections, the PF should be removed. This PF can then be used for other crops or re-used the following year.

vi) *Intercropping.* Since there is more space between the rows of newly established sugarcane fields, proper intercropping can fully utilise land and increase income. For example, in Yiwu county, Zhejiang Province, several crops were interplanted in a sugarcane field covered with PF and harvests were 870 to 1,125kg of good soyabeans per hectare, 90,000 to 10,500kg of potatoes per hectare, 17,295kg of sweet potato vines per hectare, 71,430kg of cucumbers per hectare, and 34,500kg of kidney beans per hectare. According to research carried out, intercrops did not influence the yield of sugarcane and, in some places, the yield of sugarcane still reached 75 to 135 tonnes per hectare. It is recommended that cash crops be planted as intercrops, e.g., water melon, sweet peppers, tomatoes, egg plant, and garlic.

vii) *Removing PF and Management after Removal.* If the temperature under PF reaches 40°C, the PF should be removed, otherwise the young sprouts will be scorched. But if the PF is removed too early, it will affect the growth of sprouts and reduce the rate of stooling. Timely thinning of sprouts is an important measure, because the number of sprouts evidently influences the sugarcane yield.

According to experiments carried out in Yiwu county, Zhejiang Province, when each hectare contained 165,000 sprouts and 210,000 sprouts, the yield was 130.5 tonnes and 100.5 tonnes respectively. But when each hectare contained all the sprouts produced without thinning, the yield was only 60 tonnes. For varieties with big stems, the suitable density is from 5,000 to 6,000 sprouts per hectare.

Operative Technology Suitable for Canes.

i) *Reserving Stubble Canes.* When the stubble cane field is selected, the sugarcane should be cut down using a very sharp knife, and the sprouts that emerge in autumn and winter also should be cut off. All cut sections should be flat in order to avoid tearing the PF or making holes in them. In areas where the air temperature is high, when the sugarcane is cut down the stubble cane should be immediately covered with PF to not only prevent the cut section from diseases and germs but also to control water evaporation from the stubble cane field. In areas where the air temperature is lower, treating the stubble cane and covering them with PF should be carried out late, for example, it can be carried out from the beginning of February to the beginning of March.

ii) *Digging Furrows and Loosening Soil.* During the whole season of growth, soil piles up on the ridges that are subjected to the sun and rain, therefore the soil becomes very hard. The underground buds are pressed by the thick, hard soil, so it is very difficult for them to emerge. In practice, the later the buds sprout, the higher their mortality rate. That is why digging furrows between ridges and loosening the soil between sugarcanes are very important measures. Usually, the furrows should be dug more than 10 to 13cm deep and the old soil, piled up the previous year, should also be dug over. The soil between sugarcanes should be loosened and turned over and the old cane should be revealed. If digging furrows and loosening soil are not carried out thoroughly, the rate of sprouting will evidently be reduced.

iii) *Applying Fertiliser.* As the period of sugarcane growth is very long, it is difficult to apply fertiliser after spreading PF. The sugarcane field needs application of more basic fertiliser to meet the requirements for the whole period of growth. It is recommended that miscellaneous, indigenous manure, at the rate of 15,000 to 45,000kg per hectare; calcium superphosphate, at the rate of 375 to 750kg per hectare; and potassium chloride, at the rate of 150 to 225kg per hectare, should be applied. In sugarcane fields that are located on hill slopes, application of fertiliser should be combined with irrigation because the soil lacks water. It is recommended that semi-liquid manure, at the rate of 45,000 to 60,000kg per hectare, be applied to sugarcane fields in hilly areas.

iv) *Controlling Pests and Diseases.* Sugarcane borers and grubs are the most common pests. They can be controlled by spraying a solution of Phoxim (6-9kg Phoxim plus 15,000kg water) before covering the field with PF. In order to protect the cut section of the stubble cane from disease and germ infection, 0.2 to 0.5 per cent of Bavistin or Thiophanate should be sprayed on the cut sections immediately after harvesting the sugarcane.

v) *Spreading PF.* Since the size of the stubble cane is bigger than that of newly-planted cane, the PF should be wider. To cover one row of stubble cane, the width of PF should be 60 to 80cm and the required amount of PF should be 60 to 75kg per hectare; to cover double rows, the width of PF should be 160 to 180cm and the required amount of PF should be 105 to 120kg per hectare. When the PF is spread, it

should be ensured that the edges are sealed tightly. According to research carried out, if the PF is not sealed properly, the rate of sprouting will be reduced by 30 per cent.

vi) *Removing the PF*: The duration of cover depends upon whether conditions are favourable for sprouting. If the weather is fine, the air temperature high, and the soil fertile, the duration of PF cover will be short. Usually, when the sprouts reach 60,000 to 75,000 per hectare, each sprout has three to five leaves, and the air temperature has stably increased to 20°C, it is time to remove the PF. After removing the PF, application of fertiliser and irrigation can promote the growth and strength of young sprouts. At the same time, after the sprouts have reached the expected number, the surplus sprouts should be thinned. After thinning, the sugarcane ridges should be dug out so as to restrain the unproductive stools from emerging.

Cultivation of Sugarcane Seedlings.

i) *Cultivating Sugarcane Seedlings by Using PF has Some Advantages*. First, the seedlings are concentrated in a small area so that they can easily be kept under favourable conditions, e.g., favourable temperature and humidity. They can be provided with enough water and fertiliser so that the seed canes can be saved to the extent of 1,500 to 3,750kg per hectare, and the seedlings are stronger than those emerging directly from the field. Second, since these seedlings are very strong and, even when they are transplanted into the fields, they grow quickly, 10 to 20 per cent more stems are available than those directly emerging from the field. The yield of sugarcane can increase by 7.5 to 30 tonnes per hectare and the saccharine in them can increase by 0.5 per cent. Third, sugarcane seedlings can be cultivated with PF in the slack season, and thus save labour, pesticides, and fertiliser.

ii) *Cultivating Sugarcane Seedlings with PF in Soil*. This method has been widely-adopted in sugarcane cultivation areas. The operative technology is as follows. The seed canes are soaked in two per cent of lime solution for 24 hours, and then they are removed and soaked in 0.2 per cent of Bavistin or Thiophanate for three to five minutes. This measure prevents diseases. Before layering the seed canes, sufficient water should be poured on to the seed bed and the seed canes should be laid on the bed one by one. After that, the seed canes should be covered with mixed manure and water poured on them again. Finally the PF is spread. When the sprouts emerge and two to three young leaves appear, these seedlings are ready to be transplanted. According to experience, the quantity of seedlings from one hectare of nursery beds could meet the requirements for 180 to 300 hectares of sugarcane field.

To cultivate big seedlings, the bed should be framed with a bamboo canopy and covered with PF. In this bed, when the sprouts emerge and two young leaves appear, they should be given water and fertiliser, and when five leaves have grown the seed canes should be transplanted into the sugarcane field. When the air temperature reaches 20°C, it is time to transplant. In order to ensure the survival of seedlings, the leaves should be cut down to one-third and, after the

seedlings are planted, they should be irrigated several times so that all the seedlings survive.

iii) *Cultivating Sugarcane Seedlings with PF without Soil.* This is a new improved method of cultivating sugarcane seedlings, and, compared with the old method, it can save land, labour, PF, fertiliser, and pesticides. It is also easy for farmers to learn. This method can be used not only in the field but also indoors. According to experience, the quantity of seedlings from one hectare of nursery can meet the requirements of 600 to 750 hectares of sugarcane field. The quality of seedlings cultivated by this method is very good, and the yield usually increases by 7.5 to 30 tonnes per hectare. The operative technology is as follows. In a corner of the field, a bed that is 10m long and 1.5m wide should be prepared. A layer of rice straw with a thickness of 6 to 10cm should be laid over the bed. Enough water should be poured on the bed and Dipteryx solution (one unit of Dipteryx plus 600 units of water) should be sprayed on the bed to protect the seed canes from rice borers and sugarcane borers. At one edge of the bed, a small mound should be made with rice straw and covered with pig dung, then the seed canes should be laid on the mound at 70° oblique angles, one by one. (All these seed canes should be soaked in two per cent lime solution for 24 hours before laying them out.) Then, the four edges of the bed should be mounded with rice straw and pig dung. Liquid pig dung should be poured on these seed canes on the bed and 0.2 per cent of Bavistin or Thiophanate should be sprayed to protect the sections of the seed canes from diseases. Finally, PF should be spread on the bed and the four edges of the PF should be sealed properly. Although the seed canes touch the soil, they easily suffer from lack of water, so every three to five days the PF should be removed and water poured over the seed bed. After 10 fine days (in winter) or 7 to 10 fine days (in spring), the sprouts emerge and the seedlings are ready for transplantation. If big seedlings are required, the bed should also be framed with a bamboo canopy and covered with PF. Under this PF canopy, the seedlings grow vigorously. After more than 20 fine days (in winter), or more than 10 fine days (in spring), the seedlings grow five to six leaves and are ready for transplantation.

Peanuts

Peanut cultivation by using PF started in China in 1979, and it rapidly became popular in most areas. In 1985, the area of peanut cultivation under PF reached 233,333 hectares. According to statistics, through PF, the yield of common peanut fields reaches 3,750 to 4,500kg per hectare, the yield of better peanut fields reaches 5,250 to 6,000kg per hectare, and the yield of the best peanut fields reaches 7,500kg per hectare. Generally, the adoption of PFT can increase the yield by 1,500kg per hectare.

Effects Of PF Use on Peanut Cultivation

Expanding the Area of Peanut Cultivation. PF increases the temperature of the cultivated soil layer and the effective accumulated temperature, so peanuts can be cultivated in areas where the frost-free period is short and the natural heat is not enough. PF can meet the heat required in the early stages of growth and thus prolong the whole period of growth, shorten the stage of maturation, and ensure that the normal yield is obtained.

Potential Increase in Yields of Various Varieties. In Lianoning Province, as the heat is insufficient, only early-maturing and middle-sized (nut) varieties can be cultivated but the yields of these varieties are not high. The middle-maturing and large-sized (nut) varieties can be cultivated in very narrow regions, and the yield is low, usually from about 2,250 to 3,000kg per hectare. From 1979-1985, the PF technology was popularised throughout the province. Some middle-maturing and big-sized (nut) varieties were cultivated in big areas and the yield of peanuts reached from 5,250 to 6,000kg per hectare, and, in some areas, it reached 7,500kg per hectare. In the Loess Plateau of Shaanxi Province, before 1980, the peanut yield was less than 1,500kg per hectare. From 1981, PF was introduced in these areas and the middle-maturing and large-sized (nut) varieties were cultivated at the same time. The peanut yield reached 4,500 to 5,250kg per hectare and the highest peanut yield was 9,480kg per hectare.

Increasing the Yield of Peanuts and Improving Their Quality. According to research, PF can accelerate the stages of growth, for example, emergence can be eight to 12 days earlier, flowering eight to 12 days earlier, pod setting four to nine days earlier, and maturation eight to 10 days earlier. The harvesting stage under PF in the Loess Plateau would be one month earlier than without PF. As the period of growth accelerates, the peanut yield also increases. As the plant size increases, the branches of the plant as well as the fruit increase, and the increase in yield is the inevitable outcome.

According to research carried out by the Shandong Institute of Peanut Research, when the peanut field is covered with PF, the number of fruit branches increased (1.7 to 2.9 per plant), the number of fruits increased (18 to 48 per kilogramme), the peanut pod yields increased by 20.6 to 48.7 per cent, and the peanut seed yields increased by 31.7 to 63.2 per cent. According to an analysis carried out by the Jinzhou Institute of Agricultural Sciences, Liaoning Province, PF can increase the content of the total amino acids (including 17 amino acids) by 7.22 to 18.10 per cent.

Cultivating Peanuts with PF

Preparing the Ground and Applying Fertiliser. The cultivation method is similar to non-tilling. The root system of peanuts is very strong, the taproot penetrates deeply into the soil and the lateral roots extend widely, therefore the peanut field should be deeply ploughed in order to increase the thickness of the arable layer. Deep ploughing should be carried out before winter, or in early spring, and the depth of ploughing should be more than 20cm.

Deep ploughing should be combined with the application of fertiliser, otherwise the fertility of soil does not improve. According to estimates in northern China, if the expected yield of peanuts is 5,250kg per hectare, pig dung and miscellaneous manure should be applied at the rate of more than 60,000kg per hectare, calcium superphosphate at the rate of from 300 to 450kg, plant ash at the rate of from 1,175 to 1,500kg, and ammonium sulphate at the rate of from 225 to 375kg per hectare; in southern China, cattle dung at the rate of from 6,000 to 7,500kg per hectare, plant ash at the rate of 7,500kg per hectare, calcium superphosphate at the rate of 375kg per hectare, and urea at the rate of 150kg per hectare are applied as basic fertilisers.

During the middle and late stages of growth, the pods develop very quickly and the dry materials are quickly accumulated in the

pods, therefore, additional fertiliser should be applied so that complementary nutrients are provided.

Application of additional fertiliser can be carried out in two ways; one method is to make a small hole, with a depth of five centimetres, on the ridge and at a distance of five centimetres from the peanut plant, and then apply ammonium sulphate at the rate of from 150 to 225kg per hectare, or urea at the rate of from 75 to 105kg per hectare, into the small holes. The other method is to spray liquid fertiliser on to the leaves. Suitable fertilisers are potassium dihydrogen phosphate, sodium bisulphate, and microelement fertilisers such as boric, molybdic, zinc, and iron.

It has been proved that this can promote nodule formation and increase the quantity of nodules in the root system. This measure can increase the yield of peanuts by 5.9 to 15.0 per cent and increase the rate of plump-eared seeds by 4.4 per cent.

Spreading PF. The time when PF should be spread depends on the temperature and the moisture of the soil. In hilly areas, the soil temperature rises quickly so PF should be spread early, but soil moisture should be taken into consideration. If there are no irrigation facilities in the peanut cultivation area, it is necessary to use the natural moisture of the soil, which means that PF should be spread immediately after plough-ing land, preparing the ground, applying fertiliser, and making ridges. If the water content of a five centimetres' layer of soil is less than 15 per cent, irrigation should be carried out or natural rainfall taken advantage of.

The standard ridge for peanut cultivation under PF is shown in Figure 5-1. This ridge can guarantee that the pod needles prick the PF stably. The PF should not be removed until the peanuts are harvested. According to data collected from northern China, if the PF is taken away in the middle or late stages of growing, the peanut yield decreases by 10.7 to 17.2 per cent. Nevertheless if there is too much rainfall in the growth season and there is too much water under the PF, the PF should be removed, otherwise the peanut pods will be damaged.

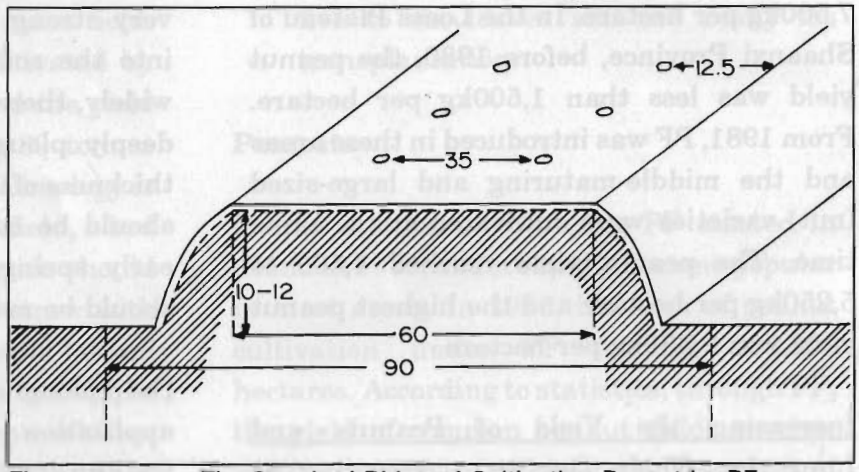

Figure 5-1: The Standard Ridge of Cultivating Peanut by PF. (Unit: cm)

Applying Weedkillers. After spreading PF, the peanut field cannot be cultivated and weeded, therefore it is necessary to spray weedkillers before spreading the PF. The commonly used weedkillers are Lasso (alachlor) and Nitrofen. Lasso is a selective weedkiller and the required amount is from three to 3.75kg of 48 per cent Lasso and from 750 to 1,125kg of water. According to a test carried out by the Institute of Plant Protection, Liaoning Academy of Agricultural Sciences, if the required amount of Lasso exceeds 4.5kg per hectare, the nodule bacteria will be affected, the quantity of nodules will decrease, and the nodules will be small.

Sowing Seeds. When to sow depends upon three factors: the date when the local frost ends, the number of days from sowing to emergence, and the minimum temperature required for the emergence of peanut seeds. The early-maturing and middle-sized varieties should be sown when the temperature of soil at five centimetres' depth stabilises at 12°C, and the middle-maturing and large varieties should be sown when the temperature of soil at a depth of five centimetres stabilises at 15°C and the soil moisture is adequate. If seeds are sown too early, they emerge slowly because of low temperatures and are damaged. If seeds are sown too late, the economic benefit of PF cannot be realised.

High-quality seeds should be selected to obtain full stands and sound seedlings. Selection of seeds is an important task which must be carried out before sowing. It is necessary to select first and second grade seeds which are big and plump, with strong germinating potential and a high germinating percentage. In addition, it is necessary to force emergence and treat seeds with nodule bacteria before sowing. Proper sowing practices are also important, and it is recommended that punching holes, pouring in water, sowing seeds, and covering them with earth should be combined and carried out continuously. The size and depth of the holes should be as follows: diameter - 4.2cm and depth - 3.5cm. Two seeds should be sown in each hole and immediately covered with earth after sowing.

Spraying Plant Growth Regulator. At the end of the blooming stage, if the plants grow too vigorously and become leggy seedlings, it is suggested that the plant growth regulator - B9 - should be sprayed to slow down the growth of stems and leaves, make the pods plump, and increase the yield of peanuts by 10 per cent. The recommended concentration of B9 is 1,000 to 1,500ppm. Another plant growth regulator - Fosamine has been tested and found to be effective. During the later stage of pod setting, 500 to 1,000 PPF of Fosamine should be sprayed on to the leaves to control the growth of stems and leaves, reduce the nutrient consumption of non-bearing flowers in the later stage, and promote the transference of photosynthates from the leaves to the pods so as to greatly increase the yield. Experiments show that the pods can be increased by 6.7 to 20.1 per cent and the seeds can be increased by 10.0 to 23.5 per cent.

Controlling Pests and Diseases. Grubs, cutworms, and wireworms are the underground pests that damage peanuts when they are in the seedling stage, and chafers, snoutbeetles, and thrips are the pests above ground that damage peanut seedlings, especially in the dry season. To control underground pests, it is suggested that a mixture of earth and Phorate (30-37.5kg of Phorate plus 225kg of fine earth per hectare) be applied in combination with constructing ridges or sowing seeds. Another method of control is to dress seeds with Phoxim. First, a solution mixed with 100 grammes of 50 per cent Phoxim and 1.5 to 2kg of water should be prepared, then 50kg of seeds should be dressed evenly with this solution and the seeds placed in a plastic bag for three to four hours. Finally, take the seeds out and dry them in the air before sowing. For the pests above ground, it is suggested that Dipteryx solution (one unit of 90% Dipteryx plus 800 units of water) should be poured into the root area. Another method of control is to prepare some branches of elm tree or poplar tree which are soaked with Dipteryx solution (one unit of 90% Dipteryx plus 500 units of water) and then they should be inserted into the soil; the pests die while eating them. Aphids not only damage the leaves and flowers but also spread

viruses, but can be controlled by spraying 1.5 per cent of Rogor powder at the rate of from 30 to 37.5kg per hectare, or Rogor solution (one unit of 40% Rogor plus 1,500 units of water). Cotton bollworm often damages the peanut leaves in the latter growth stages, but it can be controlled by spraying 0.01 per cent of Pyrethrin powder at the rate of from 22.5 to 30kg per hectare.

Peanut leaf spot, nest blotch, stem rot, and rust disease are very common in the area under peanut cultivation in China. According to the data collected from different areas, these diseases should be controlled in the early stages of occurrence (the central, diseased plants appear in the field). Peanut leaf spot can be controlled by spraying the water-dispersible powder Bavistin (one unit of 50% Bavistin and 1,000 units of water) or the water-dispersible powder Thiophanate (one unit of 50% Thiophanate and 1,500 units of water). These fungicides should be sprayed three to four times, every 10 to 12 days. Peanut stem rot can be controlled by treating seeds with the water-dispersible powder Bavistin. The weight of Bavistin accounts for 0.3 per cent of the weight of peanut seeds. Peanut rust disease can be controlled by spraying Chlorthalonil (one unit of 75% Chlorthalonil and 700 units of water) or Amobam (one unit of 45% Amobam plus 500 units of water). These fungicides should be sprayed alternately three to four times every eight to 10 days. Spraying these two fungicides alternatively would be more effective.

Tobacco

The objective of tobacco cultivation is to provide leaves of good quality. When the yield of tobacco leaves is not so high, it leaves room for improvement in the quality of leaves and increase in its yield. But when the yield reaches a certain level, the increase in yield of tobacco leaves goes into rapid decline. In the various ecological regions and under different cultivation conditions, the optimum yield, in which the quality of leaves is the best, is quite different. The proper yield scope of tobacco leaves is considered to be from about 2,250 to 2,625kg per hectare. The key measure in tobacco cultivation is to control the yield of tobacco leaves according to the optimum scope and to improve the quality of the leaves.

Effects of PF on Tobacco Cultivation

Maintaining Moisture in the Soil. The effects of PF on moisture conditions depend on the water content of the area of soil in which the root system is concentrated. During the early and middle stages of tobacco growth, if there is too much rainfall and if the soil is too wet, when the tobacco ridges are covered with PF, the water content in the area where the roots are concentrated is less than that of open land. PF is favourable for tobacco cultivation during the early and middle stages of tobacco growth. If the rainfall is inadequate and the water content in the soil is insufficient, PF cultivation is disadvantageous for tobacco. During the maturation stage, if the rainfall is too much and the soil is fertile, the tobacco plants will absorb too much nitrogen, prolonging the maturation period for tobacco and reducing the quality of the leaves. In this case, PF can restrain the rainfall entering the area where the roots are concentrated so as to ensure the maturation of tobacco leaves.

Increasing the Light Intensity Near the Ground. The quality of the leaves growing on the lower part of the tobacco plant is the poorest. Besides the physiological features, inadequate light is one of the important reasons why this is so. Since PF can reflect

light, by the use of PF more light is received by the space near the ground.

According to tests carried out in tobacco fields, in the case of vigorously growing broad-leaved varieties, after tip pruning and closing of tobacco plants, the amount of natural sunshine above the tobacco plants totalled 120,000 luxes. The intensity of reflex light on the backs of the leaves 20 to 30cm above the open ground was 200 to 300 luxes, and this is lower than the compensation point of light; that above the PF covered ground was 600 to 800 luxes, which is equal or higher than the compensation point of light. This means that PF can improve the intensity of light received by the back of the leaves on the lower parts of the tobacco plants. It also darkens the colour on the back of the leaves after curing, and this colour is usually very light when tobacco is grown on open land. PF can improve the quality of the leaves by increasing the intensity of the light reflected.

Controlling Pests, Diseases, and Weeds. Transparent PF and silver-gray PF can reflect light which would disperse aphids, so the number of aphids on tobacco leaves grown under PF is much less than on open land. Since cucumber mosaic virus is the main disease that affects tobacco, and since it is spread by aphids, PF can greatly reduce its occurrence. According to research carried out in the region where the cucumber mosaic virus prevails, during the early stages of tobacco growth, the incidence of the disease in the field covered with PF was only one to two per cent, but incidence in the open field was 51 per cent. As most varieties of tobacco cannot resist this virus, application of PF greatly increases the yield and improves the quality of tobacco leaves.

Under PF, soil temperature and soil moisture are higher than in open fields, and this creates favourable conditions for the propagation and activity of pathogenetic organisms; e.g., some diseases which spread through the soil such as root rot, black shank, and fusarium wilt (these would worsen); and other diseases which usually occur in the rainy season when the temperature and moisture are high would occur more rapidly if PF is used. This shortcoming can be avoided through alternate cultivation. In areas where diseases spread through the soil frequently occur, these diseases should be controlled by spraying fungicides before spreading PF.

Leaf diseases spread through the soil would spread quickly in open fields during the rainy season, because the raindrops spatter and transfer germs on to the tobacco leaves. If the tobacco ridges are covered with PF, the incidence of disease is greatly reduced and the air humidity near the ground is also reduced. Thus, PF can obviously alleviate the damage caused by leaf diseases.

Under the PF, weeds also grow very quickly and vigorously, and it is very difficult to pull them out. It is necessary to spray weedkillers before spreading PF. In those tobacco fields seriously affected by weeds, black PF should be used because it is very effective for controlling weeds.

Feasibility of PF Use in Cultivating Tobacco in Various Ecological Zones

In Regions with High Latitudes and High Altitudes. In these regions, although the days in which the average daily temperature is more than 20°C can meet the requirements for tobacco growth and maturation, the temperature of soil in spring rises very slowly. When the tobacco seedlings are transplanted, they grow slowly. Besides this delay in growth, maturation takes place when the temperature is low and this

adversely affects the maturation of tobacco leaves. Sometimes they suffer from damage caused by cold. PF can facilitate the transplantion of tobacco seedlings at an earlier date than normal. It can also facilitate rapid growth so that most of the leaves mature in the season when the temperature is high, which not only increases the yield but also improves the quality of the tobacco leaves. Using PF to cultivate tobacco in these regions is of significant economic benefit.

In Regions with More Rainfall during the Growing Season. Because of heavy rainfall in the early stages of tobacco growth, there are heavy soil and fertiliser losses, therefore additional basic fertiliser has to be applied. Several applications of additional fertiliser cost more money and labour. In addition, heavy rainfall makes the soil wet and brings about a decrease in the temperature of soil, consequently, the root system does not grow properly, the plants become thin and weak, and the yield and quality of tobacco leaves decline. Application of PF on the tobacco field can reduce the loss of soil and fertiliser and prevent soil from becoming too wet. Due to the increase in the soil temperature, the root system grows properly and the plants become strong. Finally, the yield of tobacco is greatly increased.

In Regions with High Temperatures and Little Rainfall during the Transplantation Stage. In these regions, the rainfall is not sufficient and is uneven during the early and middle stages of growth, but there is too much rainfall in the maturation stage. The survival rate of the transplanted seedlings is usually low and they grow very slowly. Even if there is rainfall, the seedlings still do not grow properly. The tobacco yields are not high as a result. In this region, the ability of PF to maintain moisture can be fully used. Before transplanting seedlings, the tobacco field should be irrigated or immediately covered with PF after rainfall. This measure can retain moisture under the PF and help the seedlings to tide over the dry period when temperatures are high. It must be ensured that the seedlings are not transplanted too early, because during the dry period when high temperatures prevail, moisture under the PF would be exhausted by the tobacco plants and they would be damaged or would die before rainfall.

In Regions with Low Temperatures during the Early and Middle Stages of Tobacco Growth. In the tobacco production area of the Sichuan Basin, the weather is characterised by low air temperature and more rainfall always occurs in May. Under these weather conditions, the growth of tobacco seedlings is often stagnant and they easily suffer from diseases. This leads to a reduction in both the yield and quality of tobacco leaves. But by using PF, since the soil temperature is higher than on open land, the seedlings can be transplanted early and they can grow quickly and attain the required size before the period of low temperatures and before the rainy season. These large, strong seedlings can resist the damage caused by diseases and ensure the expected yield. According to experiments carried out in recent years, under normal weather conditions, the yield of tobacco covered with PF increases by from 375 to 450kg per hectare, and, under unfavourable weather conditions, the tobacco yields increase by more than 750kg per hectare.

In Regions where Tobacco and After Crops Compete for Time. In the Sichuan and Fujian provinces, after the tobacco harvest, rice is the after crop. If tobacco matures too late, the rice seedlings cannot be transplanted in time. The gap would be prominent, especially if the temperature was low. As PF can increase the soil temperature,

it enables the early transplantation of tobacco seedlings and they grow quickly, the period of maturation can be preponed by 10 days. So rice can be transplanted 10 days earlier.

Tobacco Cultivation with PF

Spreading. In regions with high latitudes and high altitudes, when the soil thaws, there is more water in the soil, and the soil temperature rises very slowly. Sometimes the air temperature reaches the required point for transplantion, but the soil temperature is insufficient for transplantation. Even if the seedlings were to be transplanted, they would grow very slowly and bloom early, which greatly reduces the yield. In such cases, the tobacco field should be prepared in advance and spread with PF 10 to 20 days before transplantation. PF can increase the soil temperature and maintain the moisture content to provide the seedlings with favourable conditions for fast growth. In northern China, in spring, the soil moisture is not always sufficient and rainfall is always scarce. If there are no irrigation facilities, the tobacco field should be prepared in advance. PF should be spread on the tobacco ridges as soon as it rains but not when the soil moisture is insufficient after transplanting, because sufficient rainfall does not enter the area where the root system of tobacco is concentrated as the PF obstructs it. In this case, the moisture content under PF is lower than on open land. In addition, due to the fact that tobacco plants grow quickly and consume more water under PF, if the weather is dry the moisture content under the PF will be worse than that on open land. So PF should be spread when the moisture content in the soil is sufficient.

Duration of PF Use. In the hilly areas, PF should be removed when the tips of the tobacco are pruned to enable the root system to receive more rainfall. In the plains, if the tobacco plants are cultivated on big, high ridges, the PF should be replaced and retained until harvest after the tips are pruned. Generally, the duration of cover depends upon the moisture content; only sufficient moisture content in the soil can guarantee adequate yield and good quality tobacco leaves.

Planting Depth. Under PF, the taproot of tobacco is not as deep as it is on open land and the area where the roots are concentrated will be higher. When the tobacco plants flower, they can fall over in strong wind and rain, so the planting depth under PF should be one to two centimetres deeper than on open land. Often, when the seedlings are transplanted, the average daily air temperature will have reached more than 15°C, therefore the seedlings under the PF do not grow properly. This is due to the fact that the temperature in 10cm of soil is too high, and this restrains the growth of tobacco. In this case, the depth at which seedlings are planted should be increased to attain normal growth.

Application of Nitrogenous Fertiliser. Proper application of nitrogenous fertiliser is necessary to obtain the expected yield and good quality, but it is difficult to control the required amount. The exact amount of nitrogen required in different tobacco fields and in different years with varied rainfall is not known. The required amount of nitrogen fertiliser under PF should be decided according to experiment. In Japan, the amount of nitrogen fertiliser required decreases by 10 to 15 per cent if PF is used. In China, according to tests in fields which contain more organic matter and more rapidly available nitrogen fertiliser, the amount of nitrogen fertiliser is reduced. In fields which contain less than 30ppm of rapidly available nitrogen, the amount of

nitrogen fertiliser should not be reduced and in fields which have low soil fertility, especially in the hill areas, the amount of nitrogen fertiliser should be increased in order to achieve the expected yield and desired quality.

Transplanting Time. If the tobacco field is covered with PF, transplanting can be carried out well in advance, and the seedlings will grow fast and mature early. In this case, however, the maturation stage of tobacco leaves will shift from the optimum season to the non-optimum season, which would mean a reduction in the quality of tobacco. So the time for seedling transplantion should depend upon the local optimum maturing season, i.e., the maturing stage of the best leaves should coincide with the season that is most favourable for the quality of tobacco.

Jute

Effects of PF on Jute Cultivation

Since 1981, some experiments with PF in jute cultivation have been carried out in the Zhejiang and Jiangsu provinces of China. The results showed that PF can promote the early maturation, improve the quality, and also increase the yield of jute (see Table 5-1).

Table 5-1: Areas of Jute Cultivation with PF and Their Yields in Zheijiang Province, China

Time	The Area Covered with PF (ha)	Average Yield (kg/ha)	Increased Yield (kg/ha)	Compared with Contrast (%)
1981	0.13	5442.5	1279.1	30.00
1982	4.8	7832.9	1250.6	18.96
1983	47.8	7906.8	1153.2	18.44
1984	562.6	7127.7	1112.3	18.49

Source: Chinese Association of Plastic Film Technology 1988

According to experiments conducted by the Xiaoshan Institute of Jute and Cotton Research, Zhejiang Province, PF can increase the yield of jute by from 1,875 to 3775kg/per ha and the increased rate is about 70 to 90 per cent. In addition, other features also improved, for example, the height of jute covered with PF was higher than that of jute without PF by from 7.4 to 13.9 per cent; the stem diameter was bigger by from 7.3 to 17.3 per cent; the length of the fibre was longer by 22.9cm; the strength of the fibre increased by 4.6kg per gramme; and the number of fibre layers, the total number of vascular bundles, and the number of fibrocytes were evidently more than that of jute without PF.

If PF is used, jute seeds can be sown about 10 days earlier. Accordingly, the harvest date will shift and the yield of jute will not decrease. After the jute is harvested, the rest of the growing season can be used for planting other vegetables, e.g., radishes.

PF not only increases temperature, retains moisture, maintains the soil in a loose condition, and increases the efficiency of fertiliser, but it also restrains the root

nematode disease which affects jute. According to research, the incidence of disease decreased by 30 per cent and the index of disease decreased by 46.5 per cent when PF was used. In the case of jute culture without rotation, PF increased the yield of jute remarkably.

Use of PF in Jute Culture

Ridge Construction. The width of ridges will depend upon the width of PF. If the proper width is selected, the benefits of PF can be fully realised, i.e., the effect of PF on temperature increase. If two lines of jute are planted on the ridges, the width of the ridge should be 45 to 50cm and the width of the PF should be 70 to 80cm; when the lines of jute are planted, the width of the ridge should be 80 to 90cm and the width of PF should be 120cm. During interplanting, the fore-crop should have short stalks and should be of the early-maturing variety, so that light is received and the effect of PF on increasing the temperature of soil is enhanced.

Sowing . When PF is used in jute cultivation, seeds can be sown seven to 10 days earlier than normal which prolongs the growing period and prevents the young seedlings from withering under the PF, as happens when seeds are sown late and the temperature is high.

According to practice, the sowing rate is about 18.75kg per hectare. If the sowing rate is lower than this, there would be no seedlings in some places in the fields' sowing furrows. If the sowing rate is higher than this, the cost would increase as well as the labour required for thinning. The moisture content of the soil is very important. If the soil is too dry, it will be difficult for seeds to germinate. If the soil is too wet, the young seedlings will be damaged by disease. In the latter case, the seeds can be sown first and, when the soil has dried, the PF can be spread.

Timely Removal of Seedlings. If the seedlings are removed too early, they grow very slowly. If they are removed too late, they will wither under the PF. According to practice, when 70 per cent of the seedlings emerge from the soil, it is time to remove the seedlings, and this should be carried out several times to remove all the seedlings. When all the seedlings are removed, the holes in the PF should be sealed tightly with earth to maintain the required temperature and moisture and to prevent weeds.

Application of Fertiliser. Once the jute field is covered with PF, it is difficult to apply additional fertiliser until the end of June. As the fertiliser in the soil under the PF is not easily washed away, adequate basic fertiliser should be applied before spreading PF. Usually, organic manure is applied while ploughing. Cake fertiliser and chemical fertiliser are applied by making furrows on the ridges. The depth of the furrows should not be less than eight centimetres and, after the fertilisers have been applied to the furrows, they should be immediately covered with earth. The seeds can be sown just in the furrows of the ridges. In order to prevent the premature decay of jute, application of fertiliser is necessary after the PF is removed.

Controlling Pests, Diseases, and Weeds

In some jute fields, underground pests heavily damage the young seedlings. These pests can be controlled by using poison bait before sowing and spreading PF. Rhizoctonia disease occurs often in jute fields, and it can be controlled by pouring Bavistin solution into the soil around the roots of jute or by covering the roots of jute with earth soaked

in Bavistin solution. Once the jute field is covered with PF, it is impossible to till and weed it. It is necessary to spray weedkiller before spreading PF. Rasso is considered to be an effective, low-cost weedkiller for jute fields, and it is suggested that 1.5kg/ha is the maximum amount. If the amount of Rasso exceeds this, the jute seedlings will wilt.

Mulberry

PF Application in Young Mulberry Plantations

PF has been successfully applied in young mulberry plantations. A study carried out by the Institute of Sericulture of the Chinese Academy of Agricultural Sciences demonstrated that the sprouting date of mulberries covered with PF was five to six days earlier, the growth of branches accelerated, and the maximum rate of growth was earlier by eight to 12 days than normal. Compared to normal methods, the total number of branches on each plant, the average length of the branch, the diameter of the trunk, the number of leaves on each plant, the number of leaves on each branch, and the number of leaves per metre evidently increased. Under the PF, the root system was widely and deeply distributed throughout the soil, and the total amount of roots was more than without PF. For example, the root system of a two-year old sapling under PF penetrated up to a depth of 70cm into the soil and that of plants without PF were only 50cm; the horizontal root system expanded 70 to 80cm, that of plants without PF were only from 35 to 40cm. In the case of most mulberry varieties, PF can increase their yields, but this can only be observed at certain times. Twenty days after spreading PF, there are no differences between the plants under PF and those cultivated by the normal method but, after two months, the effects of PF on mulberry plants are very remarkable.

Mulberry cultivation methods with PF are similar to those of other crops. In new mulberry plantations, PF should be spread first and then the saplings should be transplanted. Once the saplings are planted, the holes in the PF should be sealed tightly with earth in order to prevent the moisture from escaping and to prevent the growth of weeds. PF can be used throughout the whole period of growth without it being removed.

Applying PF in the Cultivation of Mulberry Saplings by Cuttings

The survival rate for mulberry cuttings is not high in many areas where there are no irrigation facilities in spring, or which have saline-alkaline soil, or low spring temperatures and cold weather. Applying PF in the cultivation of mulberry cuttings can greatly change the content of water, heat, and air in the soil so as to increase the survival rate of saplings and improve their quality.

Experiments carried out in Luopu County, Xinjiang Province, demonstrated that the survival rate of mulberry cuttings under PF reached 72 per cent, 18 per cent greater than those without PF. In addition, PF can promote early sprouts in cuttings and increase the height of saplings. For example, in June and July, the heights of saplings under PF and without PF were 8.5cm and 14.5cm respectively.

PF can help to enhance the growth rate of mature saplings by 20 per cent, i.e., there is an increase of 15,000 saplings on each hectare of nursery and the quality of the saplings is improved, so the saplings are accordingly upgraded by one grade.

The method for cultivating mulberry saplings under PF is described below.

Usually, mulberry cuttings are cultivated in middle or late April, depending upon the local weather conditions. For example, when the period of local late frost is over, cutting can be carried out. First, the nursery should be carefully prepared and enough basic fertiliser applied. Long ridges with widths of from 60 to 70cm and heights of 10cm should be built and the PF spread on these ridges. When the nursery is ready, one-year old branches should be pruned from the mother plants and cut into 25cm long sections. These cuttings should be soaked in 0.1 per cent of potash permanganate solution or two per cent of sucrose solution for 24 hours. After that, the cuttings will be ready. Each ridge can hold two rows of cuttings. The distance between rows should be 50cm and the space between cuttings should be from 15 to 20cm. By using this method, each hectare of nursery can produce 105,000 to 125,000 saplings. When the cuttings are inserted in the ridges, it must be ensured that each cutting has one winter bud left above the PF. One month after cutting, the end of the cutting will have grown calli and, after three months, the sprouts will have grown from 20 to 30cm. Five months later, the saplings will be 60cm high.