




**PLANT PRODUCTION -  
EXPLOITING THE PROCESS OF  
PHOTOSYNTHESIS TO FEED,  
CLOTHE AND SHELTER THE  
WORLD'S PEOPLES**

M S Burgers

**INAUGURAL LECTURE DELIVERED ON ACCEPTING THE CHAIR  
OF PLANT PRODUCTION AT THE UNIVERSITY OF THE NORTH  
ON WEDNESDAY 5 OCTOBER 1983.**

**PIETERSBURG**



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Mr Vice-Chancellor, ladies and gentlemen, it has been stated that a man who goes without food for 24 hours will quarrel; one who is denied food for 48 hours will steal; and one who is without food for 72 hours will fight. Thus, the difference between peace and anarchy in most countries is a matter of only a few days without food<sup>1</sup>. The truth of this statement has been proven many times, and I would like to discuss briefly the role of plants in providing the nutritional needs of the world, under the title:

"Plant Production - exploiting the process of photosynthesis to feed, clothe and shelter the world's peoples."

We have come a long way since the days of 1726 when Jonathan Swift described Gulliver's interest in the work of a member of the Academy of Laputa who spent eight years on a project trying to "extract sunbeams out of cucumbers, which were to be put into vials hermetically sealed, and let out to warm the air in raw inclement summers"<sup>2</sup>. The thermodynamics are incorrect but Swift truly got to the heart of Agriculture - to fix solar energy in such a way as to make it storable and usable elsewhere and at a later date.

Today we know that sunlight energy conversion takes place in green plants through a process called **photosynthesis**. It is the most important biological phenomenon on earth because it is the primary source of all oxygen, food and clothing, of many building materials and most sources of energy (oil, coal, firewood) used by man. There is no such thing as truly synthetic food or fibres. So-called synthetic foods are really substitute foods, that are processed and texturized from plant products such as soybeans and rapeseed. "Synthetic" fibres like nylon, dacron, orlon or polyester, used for clothing and shelter, are manufactured from plant oils and petroleum products originating from photosynthesis. Even livestock products like meat, milk and eggs or exotic foods like lobsters, oysters, caviar and many more foods from animal products, are mere links in food chains, all of which originated with the process of photosynthesis in plants and ending with man as the ultimate consumer at the end of the chain. Without fear of contradiction, it can be stated that photosynthesis is the very essence of life, the basis of agriculture and of Plant Production in particular<sup>3</sup>.

Understanding the process of photosynthesis and the factors affecting its efficiency, is the first step toward understanding crop production and increased crop yield. Adopting a photosynthetic perspective means that a truly scientific approach is being taken in the search for better crop growing practices.

The fact that the yield of Agricultural crops ultimately depends on the ability of plants to carry on photosynthesis at a high rate, merits a closer look at this all-important biochemical reaction.

#### **The process of Photosynthesis**

The simplified balanced chemical equation of photosynthesis, depicting only substrates and primary end products, can be written as follows:



The process is then described in short as follows:

Carbon dioxide ( $\text{CO}_2$ ) plus water ( $\text{H}_2\text{O}$ ) with the chloroplasts of green plant cells in the presence of light energy, produces carbohydrates or glucose sugar ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) and releases oxygen ( $\text{O}_2$ ) and water.<sup>3</sup>

With the addition of mineral nutrients from the soil, the primary photosynthetic product (glucose sugar) is converted through various biochemical processes into numerous important secondary products such as:

Other sugars; proteins; fats and oils; cellulose; vitamins; lignins and many more organic compounds.

The aim of the crop scientist is to establish environmental conditions that will enable the crop plant to photosynthesize at the maximum rate for maximum yield.

Not all the products of photosynthesis will eventually be available to produce the crop. The plant needs energy for its own growth processes and some of the solar energy trapped in sugars and other carbohydrates must be released as chemical energy by reversing the photosynthetic reaction:



This process, called respiration, is the equivalent of the breathing process in human beings and other animals. Actual growth or net assimilation rate (NAR) is a function of the relative rates of  $\text{CO}_2$ -fixation on the one hand and respiration on the other hand. These two processes are not always affected in the same way by environmental factors. Furthermore, respiration carries on for 24 hours of the day while photosynthesis, being light-dependent, proceeds only during daylight hours.

As in any other production plant or factory, the maximum rate of output of photosynthesis is determined by the rate that inputs can be supplied and by the efficiency of the process.

From the photosynthetic reaction (eq. 1) we can identify at least three inputs affecting the rate of photosynthesis i.e. light, carbon dioxide and water. A brief discussion of each of these factors seems relevant.

## LIGHT

The **nature of light** or light quality as indicated by the wave length, affects the rate of photosynthesis as depicted in Fig. 1. It is obvious that light waves in the blue (short waves) and red (long waves) regions are most effective in promoting photosynthesis. These effects must be taken into account when crops are grown in controlled environments. Best results are obtained

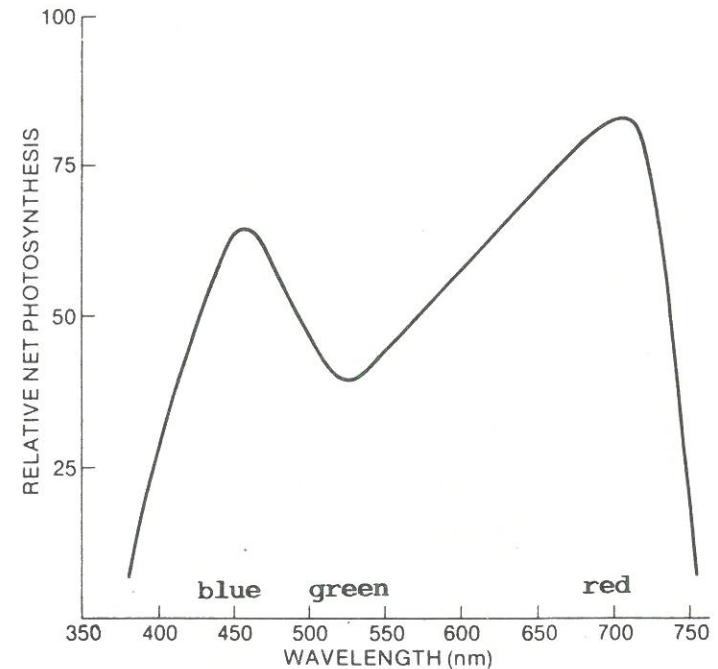


Fig. 1. - Action spectrum of a plant leaf, relating wavelength of light to photosynthetic activity<sup>4</sup>.

when a combination of fluorescent tubes (emitting short waves) and incandescent light bulbs (emitting long waves) is used as the artificial light source for growth cabinets.

**Light intensity** also has a dramatic effect on the rate of photosynthesis. The typical response curve shown in Fig. 2 is cited in many textbooks.

In the natural environment, light saturation of the photosynthetic process in an exposed leaf occurs at a fairly low light intensity ( $1/4$  to  $1/2$  of full sunlight). In the field many leaves will however, be shaded by other leaves when the crop is fully grown. Large differences in light intensities, to which individual leaves are exposed, may therefore exist within the crop canopy. Some leaves may be light saturated while others near the soil surface may intercept less light than what is needed to compensate for respiration. These leaves must then be regarded as parasitic for they may reduce the ultimate yield.

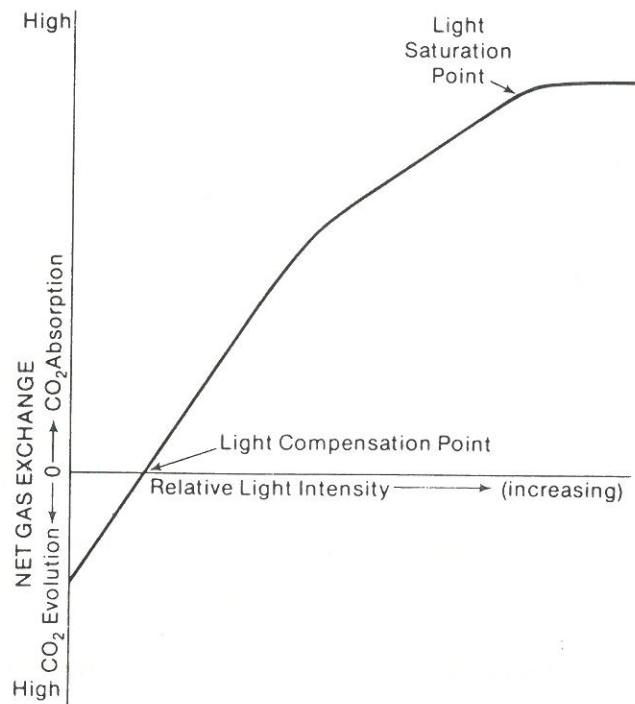


Fig. 2. - The effect of light intensity on net photosynthetic activity<sup>4</sup>.

A thorough knowledge of these effects will enable the crop producer to manipulate planting density and row orientation to ensure maximum interception of incident solar radiation. Plant architecture (Fig. 3), and leaf orientation (Fig. 4) can be altered by plant breeders to produce the ideal plant (Fig. 5) that will intercept more sunlight and increase the yield potential.

The photosynthetic efficiency of the lower leaves in densely planted crops may also be increased by using light reflectors. In one reported case<sup>5</sup> the yield of maize has been increased by 41% through the use of aluminium foil reflectors positioned on the northern side of maize rows. (Northern hemisphere). Highly reflective plastic mulches on the soil surface had similar, though less dramatic, effects in wheat, oats and maize fields<sup>6</sup>.

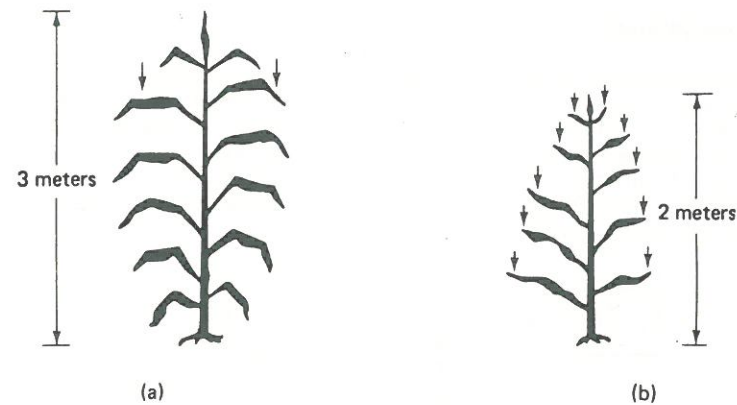


Fig. 3. - Variations in plant architecture<sup>3</sup>

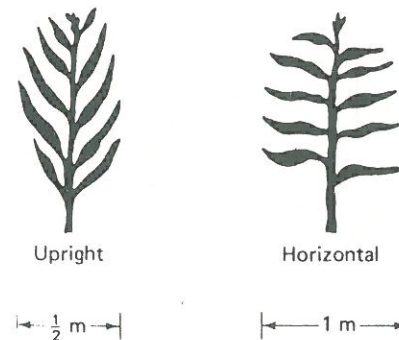


Fig. 4. - Variations in leaf orientation<sup>3</sup>



Fig. 5. The "ideal" plant<sup>3</sup>

## Photorespiration

Until quite recently plant physiologists believed that the so-called Calvin cycle ( $C_3$ -pathway) was the only universally feasible pathway of  $CO_2$  fixation. <sup>7</sup> We now know that the photosynthetic process in many plant species follows a different pathway in that the first intermediary carbon compound that is formed, is a  $C_4$ -compound instead of the  $C_3$ -compound of the Calvin cycle. This pathway has become known as the  $C_4$ -pathway of photosynthesis. (See Fig. 6)

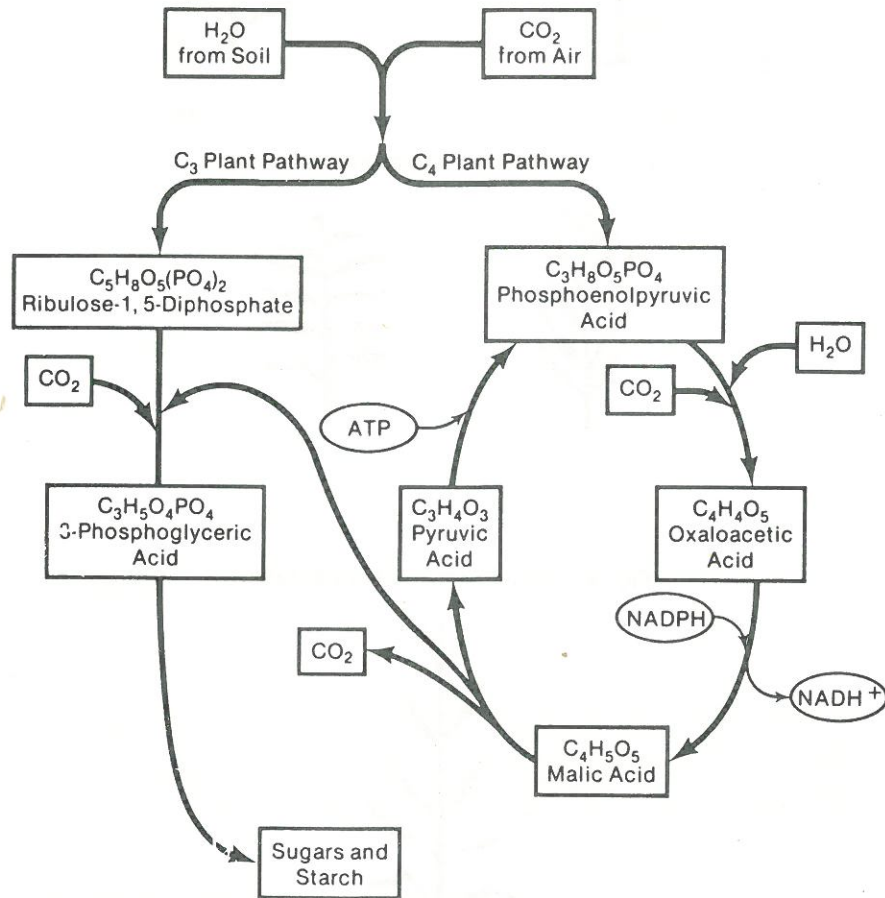


Fig. 6. - Carbon dioxide fixation (photosynthesis) pathways for  $C_3$  and  $C_4$  plants. <sup>4</sup>

According to their particular photosynthetic pathways, plants are divided into  $C_3$ -plants or  $C_4$ -plants. The  $C_3$ -group includes crops such as wheat, barley, oats, rice, rye, potatoes, lucerne, groundnuts, soybeans, cotton, sugar beets, tobacco and spinach. Examples of  $C_4$ -plants include about half of the grass family like maize, sorghum, sugar cane and millet, as well as a number of broad-leaved plants such as pig weed and Atriplex.

Plants in the  $C_4$ -group invariably were shown to be more efficient in the conversion of  $CO_2$  into carbohydrates. The cause of this striking phenomenon was found in the fact that apart from normal respiration which carries on in all plants day and night,  $C_3$ -plants are hampered by a high rate of another respiration process which is activated by light. **Photorespiration** as it was termed, is virtually absent in  $C_4$ -plants. Photorespiration was found to be affected much more by increased light intensity and temperature than photosynthesis. The resulting differential response of  $C_3$ - and  $C_4$ -plants to increased light intensity and temperature as depicted in Fig. 7, causes  $C_4$ -crops to be more adapted to warmer climates and longer days while  $C_3$ -crops thrive better in cooler climates.

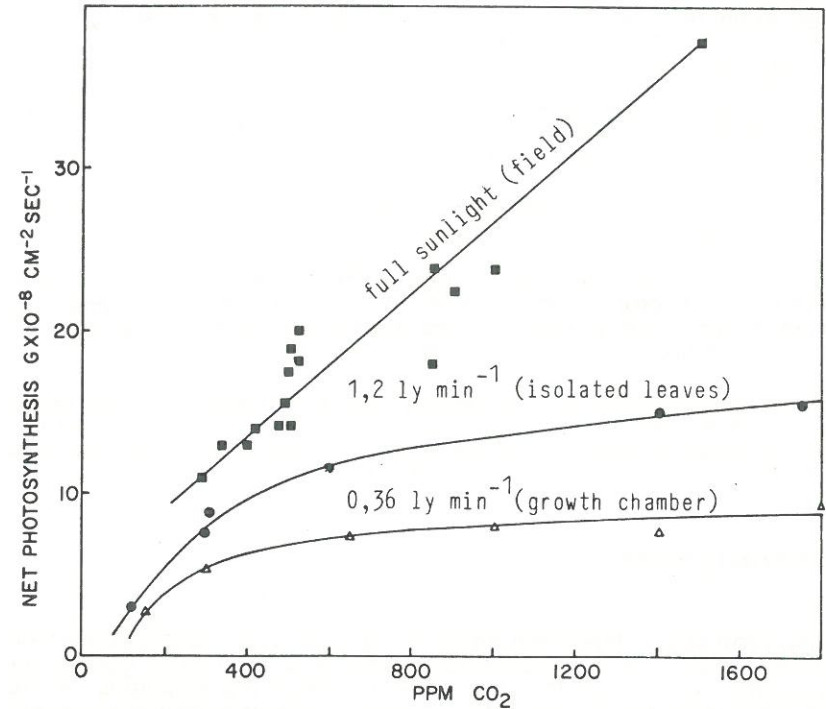


Fig. 7. - Effect of  $CO_2$ -concentration on net photosynthesis of sugar beets at three light intensities. <sup>14</sup>

It seems as if photorespiration serves no useful purpose and is regarded as wasteful. Apparently the difference in physiological pathways between  $C_3$  and  $C_4$  crops is governed by a single enzyme - ribulose diphosphate carboxylase. These findings pose a challenge to plant scientists to increase the photosynthetic efficiency of  $C_3$ -crops either through breeding or through chemical treatment.

In terms of the theoretical amount of light energy needed to convert one molecule of  $CO_2$  into carbohydrates, and taking into account light reflection and transmission, it is estimated that only about 6% of the total solar radiation (20% of the visible spectrum) is convertible to carbohydrates.<sup>9</sup>

Photosynthetic efficiencies even approaching 6% have not yet been achieved. The best farming practices in use today, yield photosynthetic efficiencies not greater than 1% of the total incident solar radiation. The discrepancy between actual energy conversion achieved in photosynthesis and the theoretical potential fixation, is tremendous. Methods to narrow this gap must be developed if a continuous food and fibre production for future generations is to be maintained<sup>9</sup>.

**Light duration** or day length affects the growth of plants in two ways. Firstly, the length of the day will determine the number of hours during which sunlight will be available each day for photosynthesis and growth. Secondly, the relative lengths of day and night, affect the reproductive development of plants and this phenomenon is called photoperiodism or photoperiodic response. For some plants to reach reproductive maturity (flowering), relatively long days (14 hours or more) are required and such plants are called long-day plants. Crops like wheat, oats, barley, rye, rapeseed and red clover respond to long days and will remain vegetative when kept under short-day conditions<sup>3</sup>.

In contrast, short-day plants require short days for reproductive development to be induced. Short-day crops include maize, soybeans, rice, millet, sorghum and potatoes. These crops fail to flower or take longer to flower when grown under conditions of long days.

A third category of crops is termed day-neutral and these crops will reach reproductive development irrespective of day length. The widespread and free exchange of seed around the world has resulted in strong selection pressure toward cultivars rather indifferent to day length.

## CARBON DIOXIDE

Photosynthesis is dependent on carbon dioxide in the atmosphere which contain about 0,033% or 330 ppm by volume.  $CO_2$ -concentration in our atmosphere is known to have increased since the beginning of the industrial revolution in 1860, and is increasing still, as a result of increased combustion of fossil fuels (See Fig. 8).

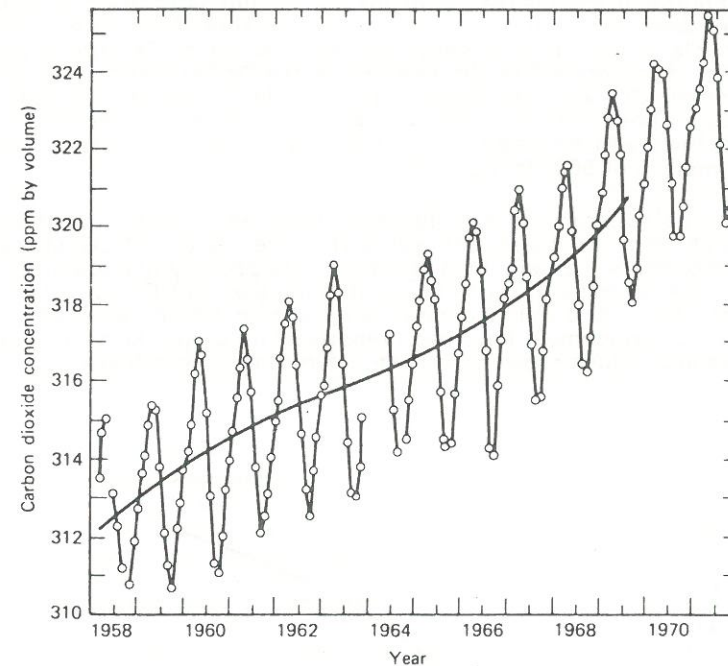


Fig. 8. - Mean monthly atmospheric carbon dioxide concentrations at Mauna Loa, Hawaii (Machta, 1972)<sup>10</sup>

The seasonal variation in  $CO_2$ -content of the atmosphere which is also illustrated in Fig. 8, is to be expected since the rate of  $CO_2$ -fixation is at its peak in mid summer, resulting in a depletion of atmospheric  $CO_2$ . In mid-winter photosynthetic activity is at its lowest level while respiration still releases some  $CO_2$  resulting in a seasonal peak in atmospheric  $CO_2$ -concentration.

It is interesting to note that until 1790 plant scientists believed plants get all their "food" from water. This fallacy stemmed from the work of the Dutch chemist Jan Baptista van Helmont in the seventeenth century. He planted a 2,27 kg willow branch in an earthen vessel with 90,8 kg of oven-dried soil. After five years during which time only water was added to the soil, the mass of the tree had increased by 74,46 kg while the soil in the container appeared to have lost only 57 grams, which Von Helmont attributed to loss of soil when washing off the roots. He concluded that growth was due to the water alone.<sup>3</sup>

Today we know that the 57 g loss from the soil was due to the uptake of fertilizer nutrients and the realization that the greater part of the dry-matter increase came from carbon dioxide in the atmosphere had to await the experiments of the Swiss scientist Nicolas Theodor de Sausure around 1790. This discovery raised the question in the De Sausure's mind as to whether more CO<sub>2</sub> would be better for plant growth. He then conducted the first CO<sub>2</sub> - enrichment trial. Unfortunately, he did not understand the relatively low levels involved and reported that plants died in an atmosphere containing 50% or 500 000 ppm CO<sub>2</sub><sup>3</sup>.

De Sausure's experiments may, however, have led to modern trials with CO<sub>2</sub> enrichment; and it was soon realized that the low level of CO<sub>2</sub> content in the atmosphere is a major limiting factor to the photosynthetic activity of plants. It seems that plants can respond to increase in CO<sub>2</sub> level of up to 2000 ppm (fig. 9) and yield increases ranging from 30% to over 120% as a result of CO<sub>2</sub> enrichment have been reported<sup>3</sup> for crops like cucumbers, tomatoes and lettuce grown in growth cabinets or greenhouses.

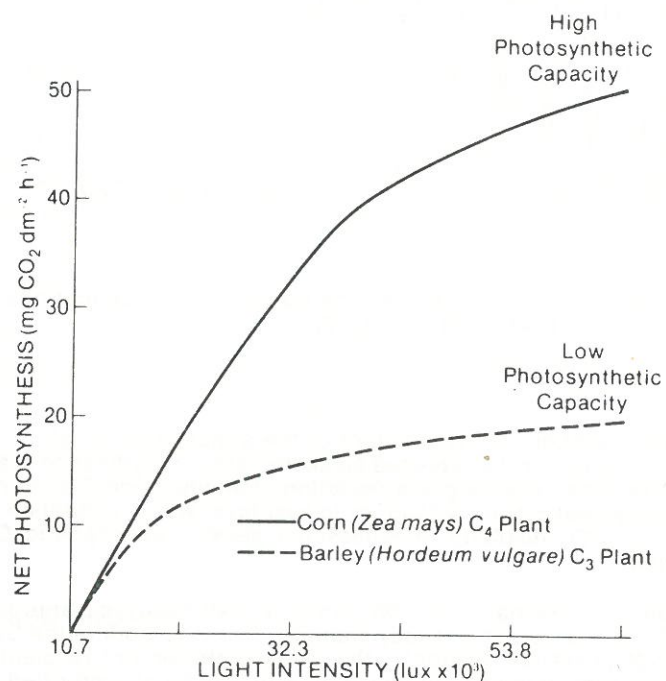


Fig. 9. - Effect of light intensity on net photosynthetic rates. <sup>4</sup>

Small wonder thus that CO<sub>2</sub> enrichment has become common practice with many greenhouse growers.

From figures 8 and 9 one may infer that the increase in CO<sub>2</sub> content of the global atmosphere, observed in recent years, may lead to an increase in the world-wide photosynthetic activity of terrestrial ecosystems, and might have contributed somewhat to the so-called "green revolution". Under field conditions, the direct addition of CO<sub>2</sub> seems impractical because of the volume of air involved. Tisdale and Nelson<sup>11</sup> nevertheless suggested that it may not be unreasonable to suppose that atmospheric enrichment of CO<sub>2</sub> for certain field crops in certain locations may someday become a reality.

Whether it is feasible or not, CO<sub>2</sub> is a key element in photosynthesis, and if crop produces understand its importance, they may be able to erect changes and practices that might result in an improved CO<sub>2</sub> environment.

Stoskopf<sup>3</sup> discusses a number of practices through which farmers might increase the amount of CO<sub>2</sub> available to his crop for photosynthesis

### Manure and crop residues

Rapidly decomposing manure or crop residues releases a lot of CO<sub>2</sub> from the soil and it has been reported that the application of huge amounts of manure, peat and straw resulted in a CO<sub>2</sub> concentration of 5000 ppm within a closed greenhouse in Denmark<sup>3</sup>.

The incorporation of kraalmanure, green manure or crop residues has undeniable advantages for crop growth. Apart from the mineral nutrients which it adds to the soil, the increased organic matter content will loosen the soil, increase waterholding capacity, stimulate micro-organism activity and release CO<sub>2</sub> during decay. To what extent the improved crop growth should be attributed to the release of CO<sub>2</sub> is difficult to determine. Monteith and his associates<sup>12</sup> estimated that the CO<sub>2</sub> supply from below the crop canopy may amount to as much as 20% of the total supply. It, therefore, seems logical to assume that the release of CO<sub>2</sub> from decaying organic matter in the soil, will increase the CO<sub>2</sub> contribution from below. One should, however, keep in mind that most of the CO<sub>2</sub> released from the soil will become lost in the atmosphere at large through diffusion, turbulence and wind.

### CO<sub>2</sub> Fertilization

The most obvious method of increasing the CO<sub>2</sub> level in a field crop would be to supply dry-ice (solid CO<sub>2</sub> at -78,5°C) to the field. Various unsubstantiated claims that cannot be duplicated suggest that yields can be increased significantly with dry-ice applications in low-lying protected areas. This idea does not appear practical because of the volume of soil involved and the enormous amount of CO<sub>2</sub> required to produce a crop (30500 tonnes for 6200 kg maize per ha)<sup>3</sup>.



## Windbreaks

If CO<sub>2</sub> fertilization is not practical on a field scale, crop producers may have to rely on CO<sub>2</sub> replenishment by means of air currents. If the air within the crop canopy remains still, CO<sub>2</sub> may soon be depleted under high rates of photosynthesis. This phenomenon was demonstrated in an experiment by Waggoner and his co-workers<sup>13</sup> through measuring the rate of photosynthesis of a sugarcane leaf in still air and stirred air with 200 ppm CO<sub>2</sub> and comparing it with air containing 300 ppm CO<sub>2</sub>. The results (Fig. 10) showed clearly that stirring of the air had the same effect as an increase in CO<sub>2</sub> concentration.

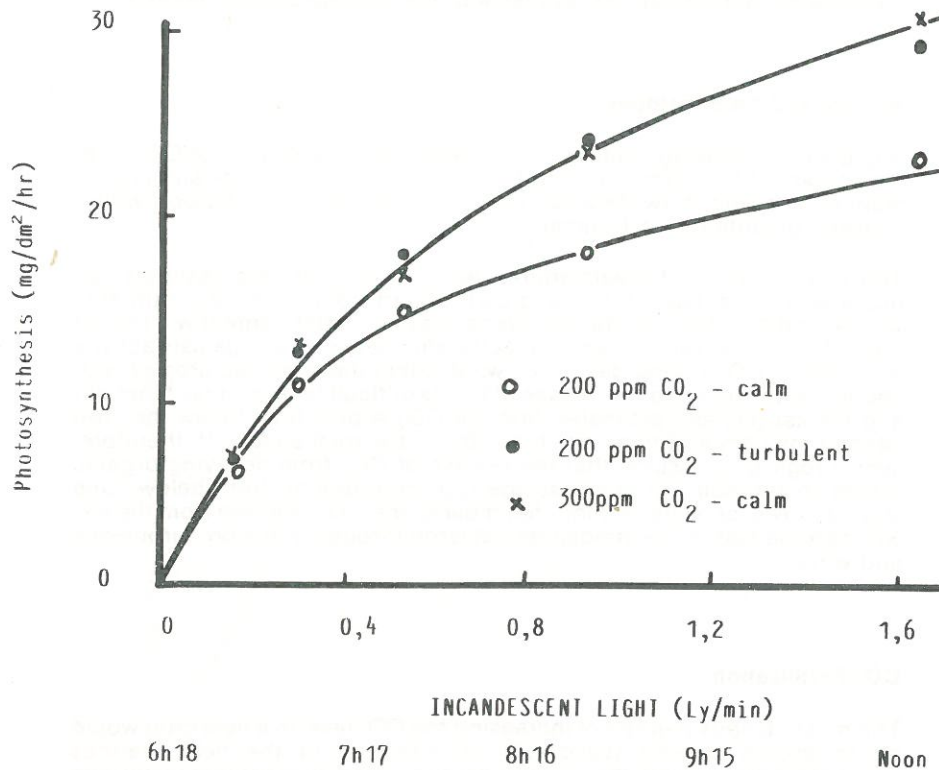


Fig. 10 - Response of photosynthesis of cane to increasing light in calm and turbulent air at two CO<sub>2</sub> concentrations (Waggoner, Moss and Hesketh, 1963) (13)

Relatively still-air conditions may exist regularly in a well-developed crop canopy which will restrict movement of air currents, even under fairly strong wind conditions.

Field crops are usually more productive when protected by a windbreak, and yield increases were attributed to a more favourable microclimate due to the reduced windspeed. Rosenberg<sup>14</sup>, however, indicated that the windbreak caused a strong turbulence within the crop canopy in the lee of the shelterbelt (Fig. 11).

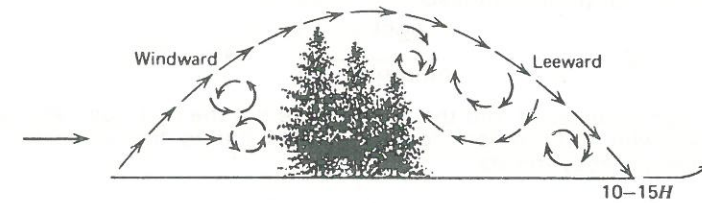


Fig. 11 - Effect of a windbreak on air turbulence<sup>14</sup>

In another study<sup>15</sup> it was found that even small temporary windbreaks consisting of maize rows at various intervals in soybean fields had a beneficial effect on the growth and yield of the soybean crop. The authors suggested that air turbulence might have been responsible for a more favourable CO<sub>2</sub> replenishment, causing the increased soybean plant response.

## Application of lime

Over 99% of the earth's carbon is locked in limestone rocks (CaCO<sub>3</sub> and MgCO<sub>3</sub>). When limestone is added to acid soil in the form of agricultural lime, CO<sub>2</sub> is released<sup>3</sup>:



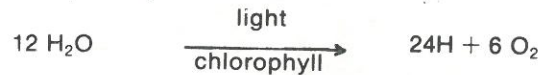
Liming is a common practice amongst farmers to correct soil acidity or pH and sometimes substantial amounts of limestone is needed (up to 9 tonnes/ha) to raise the pH to the desired level. The beneficial effects of liming are often dramatic and produce striking increases in crop growth. These benefits are attributed to: the value of calcium or magnesium as a plant nutrient; improvement of the availability of phosphorous and trace elements; enhanced decomposition of plant residues; increased availability of nitrogen and enhanced nitrogen fixation by legumes and improvement of soil physical conditions.

The possible benefit of limestone as a source of CO<sub>2</sub> has apparently not been recognised because it has not been mentioned in textbooks<sup>3</sup>. It is also very difficult to determine the extent to which limestone contributes to CO<sub>2</sub>

levels in the crop canopy and to decide whether the improved crop growth must be attributed only to improved soil conditions or whether increased CO<sub>2</sub> levels must get some of the credit.

## WATER

The first step in the photosynthetic reaction, is the splitting of water molecules. Light interacts with the pigment chlorophyll in green plant cells. The energy absorbed by the chlorophyll is then transferred to water molecules within the cell, causing the water to split during the so-called light reaction of photosynthesis :



The oxygen is released into the atmosphere but the hydrogen atoms are combined with CO<sub>2</sub> to form carbohydrates during the so-called dark reaction of photosynthesis :



For the production of a good crop of say 6000 kg/ha of dry wheat grain and the same amount of straw, only about 780 kg hydrogen, supplied by 7000 litres of water, is built into the structure of carbohydrates. However, this same crop may have used as much as 7 million litres of water/ha during its life cycle through the process of transpiration. Thus, only about 0,1% of the water that passes through plants, is actually used as raw material in the process of photosynthesis. Furthermore, most growing plants contain about 90% water and a mature maize plant may contain as much as 2 litres of water. With a planting density of 30 000 plants per ha, the water contained in the plants amounts to 60 000 litres/ha. Nevertheless, even a mild water shortage has severe effects on the process of photosynthesis. Baker and Musgrave<sup>14</sup> have shown that the rate of photosynthesis may be reduced by plant water stress, even before wilting symptoms appear. Water stress develops in plant cells as soon as the rate of water loss through the stomates (transpiration), exceeds the rate by which the soil can supply water to the roots. It seems as if transpiration serves no essential function in the plant and Kramer<sup>17</sup> described it as an "unavoidable evil". It is evil because it causes drying of the soil which eventually leads to plant water stress. It is, however, unavoidable because the stomates must remain open for gas exchange (CO<sub>2</sub> & O<sub>2</sub>) which is essential for photosynthesis and respiration.

The main purpose of an ample water supply in crop production is to maintain the turgidity of plant cells whereby the stomates are kept open to facilitate unrestricted photosynthesis. From these facts it is clear that the importance of efficient management of water supplies in crop production cannot be over-emphasized. Unfortunately, both farmers and agricultural authorities tend to forget about the importance of irrigation scheduling, and water conservation practices in dryland farming, during good times with normal rainfall. Consequently, during bad times such as what we are experiencing at present, there is usually a lack of experience and research data to cope with the problems

In addition to the three factors discussed above (light, CO<sub>2</sub>, & water) many more factors may have a direct or indirect effect on the rate of photosynthesis and crop yield. Some of them are listed below :

- temperature
- mineral nutrient supply
- soil physical conditions
- competition from weed plants,
- plant pests and plant pathogens
- genetic potential of crop species and cultivars

The crop scientist and crop producer are committed to the task of managing all factors affecting the rate of photosynthesis in such a way that the yield potential of the crop can be exploited to the full.

## University training of Crop Scientists

The factors affecting crop growth and yield can be illustrated schematically as in Fig. 12. Fig. 12 also shows the different scientific disciplines involved in studying the production process.

When, however, it comes to the actual growing of crops, it is the crop scientist or agronomist who must integrate all the information into an efficient crop production programme. The crop scientist or **agronomist**, therefore, must have a working knowledge of at least ten independent scientific disciplines. Some may regard him as a "Jack of all trades but master of none."

Early crop scientists probably derived the term "agronomy" by combining the Greek words "agros" and "nomos", with the assumed meanings of "ploughed field" and "management"<sup>1</sup>. Traditionally, "agronomy" referred to the science of "field crop production", with the exclusion of vegetable crops, horticultural crops and the management of planted pastures and natural grasslands. However, this department is responsible for research and teaching in all of these disciplines.

Hence, the name **Plant Production**. This name is also used by crop science departments at some of the other Universities in South Africa. The University of the North is, however, the only institution with an established Faculty of Agriculture where rationalisation has been taken to its logical conclusion in grouping all three plant science disciplines (Agronomy, Horticulture and Pasture Science) into one consolidated department. However wise and logical such a rationale may be, Mr Vice-Chancellor, it does create staff development problems. We still have to train specialists in each of the three plant science fields. At some of the other Universities as many as 9 full-time academic staff members are employed by departments dealing with Plant Production. Furthermore, these departments have the support of departments like Genetics, Entomology, Plant Production and Biometry to supply service courses in crop improvement, crop protection,

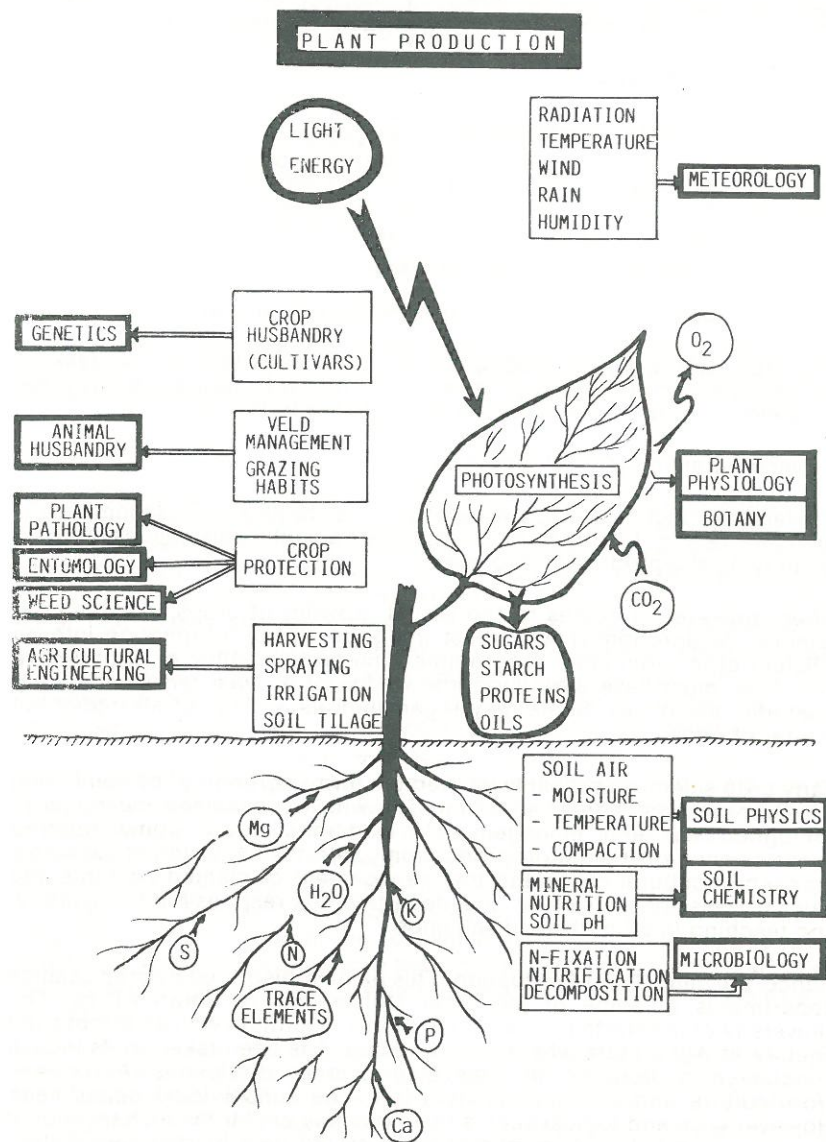


Fig. 12. - Schematic representation of factors affecting crop growth and disciplines involved in studying the production process.

research techniques and experimental designs. Most of these aspects must be included in our own syllabi, increasing the burden on already overloaded shoulders. We do not have to follow the example of other Universities, but if we aim at continuity in the department and want to secure the services of competent staff members who were recruited with extreme difficulty, attention will have to be given in the near future to the post structure in the department of Plant Production.

University training in Plant Production as well as all the other agricultural disciplines, is relatively expensive owing to the high cost of training facilities and of running an experimental farm. This is probably the reason why it took 23 years before a Faculty of Agriculture was established at the University of the North. If the importance of the Tomlinson-report was realised at the time of its publication in 1955 and its recommendations accepted by the Government, it might have been a completely different situation and Agriculture may even have been the first faculty on the campus.

Although many of the recommendations of the Tomlinson-Commission<sup>18</sup> are being carried out today, it seems to me that Agriculture still does not receive the priority which it deserves. Several recent reports by the World Bank stressed the fact that the only way in which African states can hope to survive, is by developing their agricultural potential to the full.

No one can deny the fact that education and training form the basis of development. The Faculty of Agricultural at the University of the North has a grave responsibility to produce qualified agriculturalists, who will really be able to cope with the situation. We may not neglect the training of researchers and future academics but our main concern at the moment, is the training of extension officers, project managers and officials dealing with rural development. An even greater priority, however, is the training of Agricultural teachers. I have been told that there are at least 35 schools in Lebowa alone where agriculture is being taught at matric level, while the number of qualified agricultural teachers in possession of a degree is estimated at only 2. In some schools, matric pupils are being taught agriculture by teachers who have had no formal agricultural training - not even at matric level. This is of course a problem which is not unique to agriculture. A recent research report revealed that only 2,3% of all teachers in black schools are in possession of a University degree (the figure for white schools was 28%). Add to this the unfavourable pupil to teacher ratio, poor classroom facilities, limited teaching aids, and lack of exposure to newspapers, magazines and television and it becomes clear why our students are so poorly equipped for university studies. The fact that so many of them do so well is evidence of an unexploited potential and unmatched perseverance.

Mr Vice-Chancellor, I am convinced that this University will by no means be at fault if we put a much greater effort into the training of new teachers as well as improving the qualifications of existing teachers by in-service training.

For the same reasons I would like to urge the Government of Lebowa to devote a much greater slice of its budget towards education. In the long run, such a policy will result in a decline in the demands for Government contributions towards social welfare, pensions and health services. The

saying : "Give a man a fish and he has food for one day, but teach a man to fish and he has food for the rest of his life", is still as true as ever.

### Community Service

Although the training of graduates must be regarded as the main concern of a University department, we cannot overlook our responsibility towards the community which we serve. I am convinced that a department in the Faculty of Agriculture at the University of the North cannot function properly, unless it gets involved in development programmes within the rural areas.

Because of the long delay before Development Corporations were finally established and before the importance of Agricultural development was fully realised, very little research on agricultural development was done in this country; and people with experience in this field who also have the correct attitude and are truly dedicated to the task, are extremely scarce.

Involvement in development programmes will therefore also serve as a training ground for our lecturing staff. One cannot teach students who must go out to stimulate agricultural development, if one does not know how to go about it. We are therefore fortunate to have on our staff, Mr Andre de Villiers as head of the Department of Agricultural Economics. His experience already proved its worth when the Faculty formulated policy guidelines for the way in which we want to get involved with development research and community service. These guidelines served before Senate during its last meeting. Three areas were identified where the Faculty of Agriculture may be able to contribute to the promotion of agriculture within our target areas :

1. Development research which may be carried out under contract for, and financed by, any of the development agencies such as the Department of Agriculture, the Development Bank of Southern Africa or the Development Corporations. Examples : new crops and cropping systems, new or improved small and large stock breeds, grazing systems, etc.
2. Advisory services on : soil surveys; fertilizer recommendations; planning, management and evaluation of agricultural projects; etc., as well as farmer's days.
3. In-service training of farmers, project managers, extension officers and other officials involved in agriculture.

The Faculty regard this aspect of its duties as such a high priority that it may be necessary to extend our staff and facilities to meet the demand for such community services. The Department of Plant Production in collaboration with the Department of Agriculture in Lebowa and the Mophapo Tribal Authority, recently got involved with a dryland crop production project, and some progress with the training of farmers and improved crop yields during the past season can be reported.

### The experimental farm

The 1750 ha comprising the experimental farm, Syferkuil, of the University of the North is an extremely valuable asset and we intend to make full use of it. Agriculture is an applied science and it is only natural that practical training should receive the attention which is its due. All the relevant farming enterprises have to be demonstrated on the farm and this inevitably results in some overcapitalization as far as farm buildings and facilities are concerned. We have, however, tried to erect only functional multi-purpose buildings. It is our earnest intention, after all training facilities have been supplied, to use these same facilities together with the full agricultural potential of the whole farm in such a way that it may be completely self-supporting. We may even be able to make a little profit which can be used for future development.

It is with this goal in mind that the department of Animal Production is establishing a Bonsmara cattle stud and envisages extending the milking parlour into an economically viable dairy enterprise. At the same time the department of Plant Production is developing some 50 ha of the best soil for irrigation purposes to support the dairy herd and for the production of cash crops. Vetsak has agreed to supply us with a large centre pivot or linear automated irrigation system through the NTK which can be paid for out of production under the system, over a period of 5 years.

The departments of Soil Science and Agricultural Economics will play an indispensable supporting role during the development and running of all of these enterprises - thereby completing the picture of a closely knit family basis on which we intend to run the experimental farm.

Mr Vice-Chancellor, I am grateful that I can report that all the members of the Faculty of Agriculture are well motivated and eager to participate in all of the activities which I have outlined above. I can assure you that we look forward to a very exciting future for this youngest faculty of the University of the North.

In the latter part of my address I have strayed somewhat from the aims of the department of Plant Production to elaborate on the activities of the Agricultural Faculty as a whole. I have done this to stress my belief that no agricultural department should operate in isolation. If it does, it will only be to the detriment of the combined goals of the whole faculty in teaching, research and community service.

In the same context I would like to refer to the involvement of the Lebowa Government and specifically the Department of Agriculture, with our Faculty. Since we are working towards the same goal and within the same target area, it is essential that close co-operation should exist between us when training programmes and development projects are planned. I AM pleased to report that an excellent relationship with this department has been established. The co-operation that we experienced from them with the establishment, of the Pedi-cattle herd, and with the development of the experimental farm, is evidence of their goodwill. We look forward to continued co-operation in many spheres in the years to come.

In conclusion, Mr Vice-Chancellor, allow me to put the relative importance of the different agricultural departments into humorous perspective. I have pointed out that farm animals should be seen as mere links in the food chain or as "harvesters" of plant products, processing them into more palatable foodstuffs. It is therefore incomprehensible why Animal Production as a course of study is always much more popular with students than Plant Production. Maybe the reason for this paradox should be looked for in the fact that Homo sapiens evolved into a creature with a craving not only for red wine, but also for red meat. (See Fig. 13). Plant scientists were therefore compelled to allow Animal Production to develop into an independent scientific discipline to exploit this weakness of man for consuming large quantities of all kinds of meat.



Fig. 13. - Animals are mere links in the food chain, processing plant products into more palatable products for consumption by man at the end of the chain.

Mr Vice-Chancellor, with due appreciation of the enormous task ahead, I accept the chair in Plant Production at the University of the North and pledge to serve the University, the students and the community to the best of my abilities. May God help us all to make this part of the world a better place to live in.

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