POSITION OF THE SUNFLOWER IN WORLD AGRICUTLURE

By

Dr. J. R. Jensma
Unilever Research Laboratorium Duiven
Zevenaar, The Netherlands

The pattern of the world production of edible oils in gradually changing. The time in which the developing countries were exporters and the developed countries importers is passing and we are approaching a period where the situation will be reversed.

Table 1

Annual World Seedoil Production, by Countries, 1960-1980 (in millions of tons)

	1960	1970	1980
Developing countries	9.1	10.9	13.4
Developed countries	8.7	13.7	19.7
World	17.5	24.6	33.1

Ten years ago the tropical countries produced some 20% more seedoil than the industrial ones, but if present trends continue, the industrialized countries will be leading by more than 10% in 1980. The picture becomes clearer when we compare the production of typical tropical oils with that of the moderate oils of soybean and sunflower.

Table 2

Annual World Seedoil Production, by Crops, 1960-1980 (in millions of tons)

	1960	1970	1980
Soybeans, sunflower, rape	4.9	10.0	15.0
Groundnuts, palm, copra	5.8	6.9	8.5

The very rapid expansion of American and Russian oils and the relatively slow growth of tropical oilseed crops are mainly responsible for these changes. These trends may have a considerable impact upon future world supply, especially in view of the differences in population growth rates in the two parts of the world.

Table 3

Annual World Production and Consumption of Edible Oil, 1970-1980

		Developed Countries		Developing Countries	
		1970	1980	1970	1980
Population (x 1000 million)		1.0	1.3	2.6	3.3
Consumption of oil per capita (kg)		12.4	14.8	3.4	4.4
Total consumption	(million tons)	15.7	19.2	8.9	14.5
Production	(million tons)	13.7	19.7	10.9	13.4
Surplus (+), deficit (-)	(million tons)	- 2.0	+ 0.5	+ 2.0	- 1.1

I have made the following assumption:

- population will grow 1% and 2% per annum respectively in the developed and developing countries.
- consumption will increase 2% and 3% per annum respectively.
- production will increase at the same rate as in the last decade, with the exception of palm oil for which production will grow at twice its present rate.

If these assumptions are correct we find that the import requirements of the developed countries will decrease gradually. In due course they will become fully self-supplying since, on account of their highly developed agriculture, supply will outstrip demand. The developing countries on the other hand will be unable to export their surplusses since, on account of increasing population and prosperity, they will need more oil for domestic market. They will in fact need to import and there may well be a world shortage. Regardless of supply and demand, a shortage may arise in these countries because they cannot afford to spend foreign currency on foods. In some countries there is already a real shortage of edible oil.

Now the assumptions I made are open to argument. Will the standard of living in developing countries indeed increase 3% annually and consumption proportionally? Will population growth indeed in all developing countries be of the same magnitude? Is the need for oil indeed of the same order as in the affluent countries of the world, and will food habits be essentially the same in 1980?

As in any forecast there is a high degree of uncertainty involved but I think we can all agree on the principles if not on the time scale. The differences in growth rate of population, consumtpion, and production in the prosperous and in the less prosperous countries are well know and our statements are not new: export of certain tropical oils from some countries has already dropped. We may conclude that the developing countries are facing a shortage of edible oils. To fill this gap the sunflower is eminently suitable.

To begin with it produces a very high yield of oil per unit surface area and per unit time. Yields of 1000 kg oil/ha have been obtained within 3 months and an annual yield of four times that quantity of 4000 kg is feasible. This is not bad compared with a good palm oil yield of 6000 kg. On account of its short growing period the sunflower can easily be grown in between two other crops at times when the land may otherwise lay idle. The oil/meal ratio of 3:2 is particularly favourable, for those countries where oil is more in demand than meal, which is the case in most developing countries.

The oil can be extracted with simple, inexpensive and harmless equipment, whereas palm and soybean require a higher capital investment in equipment which requires more know-how and skill to operate. Last, but certainly not least, the quality of sunflower oil is superior to that of most other oils, in particular from the nutritional point of view. Now that the public at large is better informed about the relation between fat consumption and cardiovascular diseases, we may expect an increased demand for the soft oils at the expense of palm and coconut oil. Thus the market position of sunflower oil is stronger than that of most other oils.

We shall now analyze the environmental factors that affect the development of the crop, in order to answer two question: What is the optimum set of conditions for yield and quality and which are the critical factors? Sunflower is often said to be a "drought-resistant" crop and, although it does indeed do well under rather dry conditions, this claim has often been misinterpreted as implying that it can give a good yield where other crops fail. Experiments based on this assumption have often lead to disappointments and I will therefore elaborate somewhat on this aspect.

In an experiment in Israel seeds were planted when the soil was at field capacity and the crop was grown in the absence of subsequent rainfall or irrigation (2). A yield of 1700 kg seed per ha was obtained. With later sowings, when part of the soil moisture had evaporated, yields decreased to 800 kg/ha. This proves that the crop can indeed be grown under dry conditions but it shows also the effect of soil mosture. Irrigation can have very marked effects, particularly when carried out in the period between bud formation and end of flowering (1).

The period before planting, however, is of equal importance, because many crop failures have simply been due to poor emergence in too dry a seedbed. In the Israeli experiment, 670 mm rainfall had been registered in the months before planting. Winter rains in Southern Russia and Yugoslavia amount to 350 mm, and we feel that this is about the minimum required level, particularly on light soils. Rainfall during growing period should be not less than 200-250 mm. Low yields are reported from regions where this is 100 mm or less. Rainfall of course can also be too high, in particular after flowering. A high relative humidity prevents the seed from drying, the flower bottoms start rotting, and heavy seed losses and poor seed quality will result. A combination of 70 mm rainfall, a temperature below 20°C and less than 200 hours sunshine during the month after flowering have caused the complete failures of crops that had done extremely well up till then. We cannot as yet say which single factor is primarily responsible for this but we suspect the high relative humidity. Temperature is the second most important climatological factor. According to the literature temperature at planting should not be below 10°C, but in 3 years experiments we have obtained excellent emergence and growth at 5°C. Provided the plant has passed into the true leaf-stage it is even resistant to some degrees of night frost. This indicates that the plant feels at home in a temperate climate and that its temperature optimum is certainly below that of crops like maize, beans, and soybeans. In our climate in the Netherlands, which we consider to be marginal for sunflowers, the monthly average temperatures during growth were 12, 15 and 17°C. Nevertheless, we obtained very good yields, although the moisture content at harvest was high.

No data are available about the maximum permissible temperature but good yields have been obtained when temperatures were in the 25-30°C region. High temperatures during the growing periods, however, cause a lowering of the linoleic acid content of the oil. This has been shown by Canvin (6) who found the following relation:

Table 4

Effect of Temperature
on Linoleic Acid Content of Sunflower Oil

Temperature (°C)	10	16	21	26.5
Linoleic Acid (%)	78	59	35	29

I would like to emphasize this point because it is becoming increasingly important. A minimum of 50% linoleic acid is required if the oil is to be used for premium quality margarine. It would be a good thing if varieties could be bred that gave high linoleic contents at high temperatures.

If we now sum up the climatological requirements we find the following:

Table 5

Climatic Requirements of the Sunflower

	Before Emergence	Emergence - Flowering	Flowering - Harvest
Rainfall (mm)	> 300	> 200	< 80
Temperature (°C)	> 5	15-30	> 20

These data are based on empirical evidence rather than on experimental results. What we need is a careful analysis of yield and weather over long periods so that the relative importance of each single factor can be given with more precision.

So much about the climate, I now come to the factors which the farmer himself can influence. I will not discuss all the details of good farming practice, but instead concentrate on one aspect, namely density. Table 6 lists the recommendations of various research workers.

Table 6

Recommended Plant Densities in Different Climates (x 1000 plants/ha)

Author \ Climate	Arid	Semi-Arid	Humid
Semihnenko (3)	25 - 30	35 - 40	47 - 56
Cargill (4)	35	55	75
Masson (3)	-	-	60 - 80
Pinthus (2)	33	-	-
Gandy (5)	-	-	55 - 85
Faure	-	-	150

We see that the recommendations for the arid regions do not differ widely. In the semi-arid and humid regions, however, the non-Russians tend to be more generous than the Russians. The odd man out is Faure, from our laboratory, who compared 8 densities (1.5 to 15.2 plants/m^2) in a very humid area. At the highest density, yield was 3.5 ton of seed and 1.5 ton of oil per ha, while the husk content was reduced from 40 to 24% and the oil in the kernel increased from 60 to 76%.

What now are the yields achieved in practice and what can be expected in the future? Yield depends, as we know, upon two major types of factor: firstly, the natural conditions like soil and climate, and secondly, the manmade environment, i.e., irrigation, nutrition, disease control, crop management. Now yield varies strongly from year to year, mainly owing to variations in weather. Yet, seen over longer periods, yields in most countries tend to increase, due to improvements in agricultural technology. The latter aspect is clearly demonstrated by the data from Table 7. We find that in East-European countries yield increases by an average 40-50 kg per ha per annum.

Table 7

Increase in the Yield of Sunflower Seed per Hectare in Five Countries

	Yield per ha. (x 100 kg)		Increase per Annum (kg per ha)
	1948-1952	1966-1968	
Yugoslavia	8.5	19.2	63
Bulgaria	8.4	16.8	49
Rumania	4.6	14.4	58
U.S.S.R.	5.3	13.3	47
Argentine	7.3	8.8	6

It is interesting to note that in the U.S. yields of soybean increased over the same period by 21 kg per ha, wheat by 35 kg per ha and maize by 100 kg per ha.

Yield therefore is a very dynamic and complicated concept but, if experience in Yugoslavia is anything to go by, it seems safe to conclude that where the climate is right and the technological level of agriculture is adequate a yield of 2000 kg per ha and an annual increase of 60 kg per ha is certainly possible. On some large fields in Yugoslavia yields of 4200 kg per ha have been obtained, so we may safely extrapolate the 60 kg annual increase in yield for at least 35 years.

It would of course be wonderful if this period could be shortened to say 15 years and here we find the challenge to research. I would like to suggest which research topics deserve first priority:

- Firstly, there is the effect of density. This could be clarified in a relatively short time at low costs, whilst the potential benefits are considerable.
- Secondly, there is the effect of irrigation, correct timing of which will increase yield at relatively low costs.
- Thirdly, there are the effects of incompatibility. This is a far more complicated problem but we know from our experience with other crops that a better understanding of it would help greatly in breeding better-yielding varieties and hybrids.

Several more topics could be mentioned, but these will in my opinion have the most direct influence on yield and quality.

The sunflower is a most facinating crop, that could become an important source of calories for people in the developing countries and a source of foreign currency to improve their balance of payments, Moreover, it could help to improve the health of the people in the developed part of the world. To realize this potential is the great challenge to the bioscientist and the industrialist.

* * *

References

1. Robelin, M. Action de la secheresse sur la production de la tournesol. Ann. Agron. 18 (1967) 579 - 599.

2. Pinthus, M. J. Some environmental effects on the oil yield components of sunflower seeds. Quat. Plant Mat. Veget. 9 (1963) 329 - 335.

3. Masson, C. G. Le tournesol en Roumanie, Russie et Yugoslavia Rapport CETIOM, 174, Av.Vict. Hugo, Paris.

4. Cargill, Sunflower Growers Handbook, Minneapolis, Feb. 1968.

5. Gandy, in Bulletin No. 38, National Cottonseed Products Assoc., Memphis.

6. Canvin, David T. The effect of temperature on the oil content and fatty acid composition of the oils from several oilseed crops. Canadian Journ. of Botany 43 (1965) p. 63 - 69.