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ADDRESS TO SORGHUM AND MILLET WORKSHOP, 5 - 7 JULY, 1978

In the two attached tables, I have extracted from the FAO production yearbook for 1976 figures for the Sorghum and Millets crops, showing area planted, and yield per hectare. I have also picked out those countries with the largest areas of sorghum and millet, and have added the comparative figures for the maize and rice crops.



Among these four cereals, rice occupies the biggest cultivated area, followed by maize. However, looking at the developing world, the total area occupied by sorghum and millet greatly exceeds the area of maize. If we omit the American continent, and also China, where the millet grown is completely different from the pearl millet of the semi-arid tropics, then these three crops are of roughly equal importance in terms of area cultivated. In fact, there is double the area of sorghum and millet compared to the area of maize. (The 1.2 million ha. of millet in Ethiopia is almost entirely teff, while that in China is almost entirely proso-millet. The remaining millet figures are predominantly pearl millet, but there are some important areas of finger millet, and some other minor millets included also).

Yield differences are striking, especially between the developed and the developing world. Maize yields averaged 47 q/ha. in the developed world, 31 q/ha. in the centrally planned states, and 13 q/ha. in the developing world. The differences for millet are less great, although the average yield in the developed world was twice that of the developing world. For sorghum, the difference was very great, 29 q/ha. in the developed world compared to 8.5 q/ha. in the developing world. It will be seen that in North America the average yield of sorghum was 30 q/ha. Thus, we see that the yields of maize and sorghum could be trebled in the developing world, and that of millet doubled. The influence on food production would be very great, and higher yields per hectare would allow farmers to reduce

the area under cultivation. This would permit the growing of larger areas of crop for cash production, or the resting of larger areas of land as part of the important process of restoring soil condition and fertility. Basically, the better yields of cereals in the developed world have come about by the development of better cultivars, which respond to better farming methods. This then makes it possible to use increased inputs profitably, and so the upward spiral is created. As an example, yields of sorghum cultivars in the U.S.A. in 1950 were around 12 q/ha. The same land under modern sorghum hybrids is yielding about 30 q/ha., largely because the modern sorghum genotypes respond well to fertiliser and good management, so it now pays the farmer to spend more money and effort on this crop. That is why plant breeding projects aiming at developing better, more responsive cultivars are very important; and why projects to develop improved farming through the use of such cultivars are also of great value.

ICRISAT was established to meet this need for work on sorghum & millets, & IDRC has been actively helping. We support sorghum and/or millet improvement projects, or projects with these components, in Senegal, Sudan, Uganda, Ethiopia & Tanzania, as well as in Mexico. We plan to support a project in Upper Volta, where ICRISAT already has an active programme. ICRISAT also has scientists working on these crops in Senegal, Mali, Niger, Nigeria, and the Sudan and Tanzania, while UNDP are supporting a project in Kenya.

The yields in the tables also give an indication of the differing ecological habitats of these four cereal crops: rice needs plenty of water, few people would attempt to grow a maize crop in a flooded rice paddy. Similarly, millet is able to grow on relatively little water, few people would attempt to get a maize crop on the dry light sandy millet soils of the world. (Irrigation may totally change the picture, for example, as soon as irrigation is introduced into sorghum areas of India, the sorghum is largely replaced by wheat).

We are therefore faced with the situation that it is necessary to match the cereal type grown to the growing conditions. If reliable and good yields are to be obtained on the rain-fed, heavier soils of the dry tropics, then sorghum must be grown. Similarly, on the light sandy soils of the dry tropics, millet must be grown. Maize will only yield in favourable seasons, and will fail completely in others: it is therefore undependable in such areas. Farmers have learnt this from experience over many hundreds of years.

It is possible to bring about certain changes in characteristics of crop plants by plant breeding: but it is not possible to change the fundamental nature of the crop plant: one cannot breed a maize type which can grow in a flooded rice paddy, nor can one breed a maize type which will give consistent yields on rain-fed, dryland light sands such as those on which the millets flourish. There will always be extensive areas of the rain-fed tropics where sorghum and millet are the main cereal crops.

Two major problems, causing severe yield loss on both crops are birds, and Striga (witchweed). We can hope for much progress in solving the latter problem now that we have ICRISAT to work on it. The bird problem is a much more serious one, and one which interacts with grain quality. Unfortunately, the grain types which people like best are those which the birds also like best. Birds represent the biggest problem for the sorghum and millet growers of the world today, but it should also be remembered that they were a major problem in all the cereal growing countries of the world in the past, and can still be quite a nuisance today, even in highly developed countries. Usually, the development of continuous cultivated areas with little low bush and scrub help to reduce the breeding and roosting sites for birds, so that although they may do damage on the edge of the cultivated areas, the damage which they do overall is not serious. Reorganising the countryside is a part of the answer to the bird problem, and anybody who knows Sukumaland in Tanzania will find that the farmers do

eliminate a lot of the trees, and bushes. This is not contrary to the forestry needs of the countryside, because tree plantation can be located in blocks in suitable places, and need not be a source of birds on the crops. However, Africa has a particular problem of its own. There is a small weaver bird called Quelea which multiplies in enormous numbers and moves around in swarms like locusts. I can see no possibility of controlling these birds by reorganising the countryside, but I am sure that a cooperative scheme to control these birds over the whole continent of Africa will one day be developed.

The birds which damage the cereals are the grass seed feeders: if there is plenty of grass seed about, the bird damage is relatively less serious, although birds such as Quelea like the best quality sorghum and millet grains better than the grass, and can be a great source of trouble. By "best quality", I mean those grains which the people like best. However, it is possible to find less palatable grain types which people can use as food, but which the birds do not like as much as they like their grass seeds. Where these types are grown, the bird problem is only serious when the grass seeds have been eaten.

Many of the brown grains, or white grains, or white grains with a dark sub-coat, fall into this category. For example, in the highland areas of western Uganda, such types are grown, and in order to use them as food, they are germinated in damp wood ash, which helps to destroy the bitter polyphenols, and at the same time to convert the starches to sugars. After being allowed to germinate for a few days, this malted grain is then dried, and ground to make a sweet porridge. This porridge may be fermented for varying periods of time, and much of it is in fact eaten when the alcohol levels are still quite low: but some of it is also used when the alcohol level has become high. Thus, in many areas where brown grained sorghums are grown, the people are said to live on beer. What is really happening is that people have found out how to use as food grain

types which the birds leave alone except in the bad years when there is no grass seed.

In Maiduguri and Botswana IDRC have been learning how to remove the outer grain layers in a special mill, which pearls the grain. We hoped that it would be possible to do this with grains processing a dark sub-coat, which are less bird susceptible. At present, we have run into two problems: the sub-coat layer is deep down, so wastage is high: and there seems to be some kind of close association between a rather soft grain and the presence of the sub-coat, so that the grain crumbles and disintegrates in the pearler.

At the present time, one cannot disentangle the problem of grain quality from the problem of birds:* some areas are relatively fortunate, with few grain eating birds: others find this a severe practical problem.

Grain quality is not always easy to define, and ultimately depends on the taste and cooking method of the consumer. However, there are some generalisations which are possible: rice is a very acceptable grain to mankind, although the kind of rice and the preparation methods may differ widely; red rices are preferred to white rices in some areas, par-boiled rice is preferred to untreated, and the rice enjoyed in Sri Lanka would not be liked in many other Asian countries. However, the fact still remains that rice as rice is a preferred grain.

The next most popular grain is wheat, and although a large part of its popularity is due to the fact that it makes a raised bread, yet still it is very acceptable as an unleavened bread. Maize is generally preferred to sorghum and millets, and here, one of the considerations is the length of time for which the consumer feels satisfied. For example, people from the Tabora district of Tanzania who work in sedentary jobs, find sorghum a 'heavy' food, and much prefer maize. However, if they are going out to do a day's hard field work, they much prefer the sorghum,

which they say sustains them better. We are dealing with a very complex topic.

It has often been said that rice and wheat are prestige foods, and that sorghum and millet tend to be despised because they are not prestige grains. I do not accept this for one moment: I think that the differences we have been considering are a reflection of the characteristics of the various grains, and have very little to do with prestige considerations. Further, we have so many instances of parallel developments in the grain crops, and there is so much genetic variability available in the grain of the sorghum crop, and I suspect, also in the pearl millet crop, that I believe very considerable improvements could be made in the grain quality both of sorghum and of millet.

There are two approaches to this: firstly, we need to study the sorghum and millet grain types which people like best, in order to try to identify the grain characteristics associated with this positive preference. The plant breeder can then try to make sure that these identified characters are present in the new cultivars being developed. As you know, plant breeders work with very large numbers of genetically different lines, and cannot possibly specify all of them on the basis of their flavour, or their cooking characteristics. The plant breeder must have a handle, he must have simple tests which he can easily apply to very large numbers of very small lots of different grain. He can then throw away the ones which fail these tests, and continue working with the others. When the stage in his programme has been reached when he is testing perhaps only 25 or 50 possible lines, he can then multiply enough grain of these for full tests to be carried out on their palatability and cooking qualities. Not all will be equally good, because no simple test can ever be as effective as the proper evaluation: nonetheless, if the simple tests used earlier were at all good, he will find that more than half of the lines available at this end stage of his programme are of good quality.

We hope that this workshop will help us a great deal in working towards the discovery of simple tests which will permit the plant breeder to select positively for grain quality. Evidently many grain characters may be involved: colour, fibre content, hardness, ease of grinding, starch type, endosperm structure, protein type, aroma and flavour may all be involved. I think that we need world-wide cooperation in trying to tackle this problem of ensuring that the new cultivars being produced have grain types which the consumers would welcome. It is all too easy for plant breeders to say that "if the yield is good enough, people will grow it". This is almost an insult, all peoples have tastes and food sensibilities which need to be satisfied.

The other aspect of grain quality in sorghum, at least, which has always intrigued me involves the attempt to bring together unusual characteristics, to see whether we cannot build a grain type better than any already existing. If we just look at the protein of the grain, we find that in rice the protein contains no prolamine fraction. In wheat, the proportion of prolamine in the grain protein is relatively low. In the so-called coarse grains, such as sorghum and millet, the prolamine fraction of the protein may be more than half. At ICRISAT, we were working on sorghum types with a lower prolamine fraction than usual, because the total protein in such sorghum grains is much more nourishing. When I left, we had not yet got far enough to undertake testing in quantity of such grain types simply for their food acceptability. I would like to see this done; is it just a coincidence that the best grains have the lowest prolamine levels?

A second character which intrigued me was discovered in Ethiopia, where a cultivar was collected with a flavour distinctly like the flavour of wheat. A third interesting character is that existing in some sorghums of Sri Lanka and North east India. They have an aroma, very like the aroma of the bismati rice. These are all very different

into one grain type, to see whether it is superior to any of the existing sorghums. I think there is an intriguing possibility that we may be able to produce much better grains than any which we have at present. Obviously, this is a longterm undertaking, and therefore lies beyond the object of this present workshop; yet I did want to draw your attention to the fact that, not only do we know rather little about grain quality in sorghum and millet, but also there is reason to think that we shall one day have much better grains than any in current use.

* page 5 second paragraph

(a) The most radical attempt to solve the bird problem is that being made in the IDRC project with PRL, SASKATOON, where they are attempting the somatic hybridization of maize and sorghum.

HD/ald.

by Hugh Digget

# CEREALS

areas 1000 ha

(from FAO Prod. Yearbook 1976)

| | Sorghum | Millets | Maize | Rice |
|---|---|---|---|---|
| Africa | 13940 | 16320 | 19650 | 4580 |
| Nigeria | 5940 | 5000 | 1450 | 310 |
| Sudan | 2600 | 1200 | 85 | 7 |
| Upper Volta | 1140 | 910 | 90 | 40 |
| Ethiopia | 770 | 340 | 820 | - |
| Niger | 633 | 2530 | 7 | 20 |
| Tanzania | 600 | 200 | 1800 | 290 |
| Mali | - | 1240 | 90 | 150 |
| Chad | - | 900 | 10 | 50 |
| Senegal | - | 950 | - | 80 |
| Asia | 18960 | 53190 | 28500 | 127160 |
| India | 16000 | 20500 | 6200 | 38600 |
| Yemen | 2040 | 40 | 68 | - |
| Pakistan | 520 | 700 | 600 | 1700 |
| China | 10 | 30800 | 11550 | 35390 |
| Korea | 60 | 500 | 750 | 1970 |
| N.C. America | 7760 | 1100 | 38300 | 1760 |
| U.S.A. | 6020 | 620 | 28770 | 1010 |
| Mexico | 1180 | 70 | 7000 | 150 |
| S. America | 2420 | 240 | 16500 | 7770 |
| Argentina | 1830 | 230 | 2760 | 90 |
| Brazil | 190 | - | 11120 | 6590 |
| World | 43930 | 72810 | 118,050 | 142250 |
| Developed | 6940 | 60 | 41,160 | 4170 |
| Developing | 36680 | 38430 | 55,240 | 94640 |
| Centrally Planned | 310 | 34320 | 21,660 | 43440 |
| Asia & Africa (without China) | 32890 | 38710 | 36,600 | |