Yields obtained from two crops in a year with new varieties and hybrids at the IARI.

Rabi 1965-66		Kharif 1966		Total grain yield quintals/hectare
Crop	Yield/ quintals/ hectare	Crop	Yield/ quintals/ hectare	
Wheat:				
Sonara 64	65.6	Maize-Ganga 3	57.4	123.0
Sonara 63	60.0	Maize-Composite	50.5	110.5
Lerma Rojo	55.3	Jowar-CSH-1	50.0	105.3
N.P.876	48.6	Jowar-CSH.2	55.0	103.6
N.P.880	45.9	Bajra- HB.1	48.3	94.2

Protein characteristics of amber grain mutants in Wheat.

Variety and culture number.	Protein %	Gluten %	Mean Pelshenke value
A. Sonora 63			
Control	11.2	7.3	181
Amber mutant-1	16.4	13.6	175
Amber mutant-2	14.4	10.9	189
B. Sonora 64			
Control	12.4	8.7	180
Amber mutant-1	15.0	13.1	155
Amber mutant-2	14.5	12.9	141
C. Lerma Rojo 64			
Control	10.3	11.3	59
Amber mutant-1	15.2	14.3	73
" " 2	13.7	12.7	111
" " 3	13.7	13.1	91

Quality evaluation of Indica mutants in T-65.

Strain	1000, kernel wt. in gms.	Crude protein (%)	Grain length/ breadth x 100	Cooking time(Min)
T-65 control	21.8	9.11	133	35
IND-1	17.7	14.66	240	30
IND-3	18.4	15.76	300	--
IND-5	18.5	15.47	200	25
IND-6	18.9	15.04	183	30
IR -8	20.3	8.64	233	15
NP-130	15.4	11.35	400	20

from two crops in a year

Yields obtained with new varieties and hybrids at the IARI

Rabi 1965-66		Kharif 1966		Total grain yield Quintals/hectare
Crop	Yield Q/Ha	Crop	Yield Q/Ha	
Wheat				
Sonara 64	65.6	Maize - Ganga3	57.4	123.0
Sonara-63	60.0	Maize - Composite	50.5	110.5
Lerma Rojo	55.3	Jowar - CSH-1	50.0	105.3
N.P. 876	48.6	Jowar - CSH-2	55.0	103.6
N.P. 880	45.9	Bajra - HB.1	48.3	94.2

and

MALTHUS & MENDEL

M. S. Swaminathan,
Indian Agricultural Research Institute
New Delhi

Summary of a Public Lecture delivered by Dr. M.S. Swaminathan, President of the Indian Society of Genetics & Plant Breeding during the International Symposium on the 'Impact of Mendelism on Agriculture, Biology & Medicine' on February 18, 1965.

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Malthus was born and published his work earlier than Mendel. The work of Mendel which led to the birth of the Science of Genetics has, however, had a very deep impact on the Malthusian predictions concerning population growth and food production. It is now clear that the population of the world has increased since 1900 in a geometric proportion as anticipated by Malthus. The rate of increase in India is even higher than what would be expected on the basis of geometric progression. In the case of food production, however, the rate of increase has been on the basis of arithmetic progression as postulated by Malthus, when the figures of agricultural production for the entire world are taken into consideration. In India, however, the rate of increase in production deviates from the Malthusian law in an unfavourable direction, i.e., food supplies are not increasing even arithmetically. In the successive decades starting from 1911 there is evidence of a marked demographic change in India because of a rapid decline in the death rate. The rate of decline has been particularly sharp since 1941. The birth rate has, however, not dropped in a commensurate fashion. This situation is leading to an alarming rate of increase in population. Thus, the Malthusian doctrine is finally coming true after 170 years. At the present rate of increase in population of 2.5% per year, the population will double itself by 1993.

Gregor Mendel presented his paper on the inheritance of characters in plants before the Natural History Society in February, 1865 at Brunn (Czechoslovakia). The essential features of his findings are:

i) Distinct characters are transmitted from parents to progeny through particles which do not lose their identity in the zygote and consequently get assorted in a predictable fashion in the subsequent generations.

ii) The factors governing different characters may be shuffled and recombined in different ways in hybrid progenies. The significance of these findings was understood only in 1900 and since then the laws of genetics have been studied in great detail in many

Contd.....p/2.

organisms - from viruses to man. We now know that the genes or factors controlling hereditary characters are located on chromosomes. While the history of the earth is written in its layers, the history of living organisms is written in their chromosomes.

it is not so widely realised that

it is common knowledge that

Mendelism and population growth:

The exploitation of Mendel's laws of genetics has helped greatly in making the Malthusian concept of population growth come true. Because of the birth of genetics the following Malthusian checks on population growth have been made largely inoperative:

a) Famine: In 1845, the late blight disease of potato was the cause for the death of over a million Irish men. Today this type of situation does not occur because genes for resistance to many of the important diseases have been incorporated in our crop varieties. Also, modern communication methods and the charitable outlook of countries like the United States help in avoiding serious famines.

The Bengal famine of 1942 was caused by the destruction of the paddy crop by the fungus, Helminthosporium oryzae

b) War: A nuclear war can eliminate quite a high proportion of the human population. Though there is a large nuclear stock piled in the world today there is extreme reluctance to resort to such warfare, largely because of the harmful consequences that will flow through increased radio-activity in the atmosphere to the generations as yet unborn. While man might even agree to suffer diseases like cancer, he does not like to see his children born deformed, as is clear by the sense of horror and anger that the Thalidomide babies evoked

c) Death rate: The discovery of antibiotics has ~~led to~~ a rapid drop in death rate in recent decades. Antibiotics like penicillin or streptomycin would not be in use today to such a great extent but for the improvement in the yield of antibiotics brought about by induced mutations. For example, starting from strains of Penicllium which yielded only about 100 units in 1943, we have today strains which yield as high as 3000 units. But for this remarkable improvement, antibiotics would notbe within the reach of the common man. Thanks to genetic studies a greater understanding of the mechanisms ~~covering~~ governing aging is also being built up. As a result, we can safely expect that in a next decade or so, methods may be found for slowing the rate of aging and thereby increasing the total life span.

been a primary factor in causing

Contd.....p/3.

The growing knowledge of Immunogenetic mechanisms has also enabled great progress in surgery particularly in the field of organ transplantation. ... tissue and

~~As a result of~~ These developments and other arising from a growing ~~the population pressure is going to increase and not decrease in the near future~~, Unless very effective measures of birth control are introduced and adopted on a wide scale. Commendable efforts are being made in India to popularise birth control measures but it is my personal view that we are not going to make a dent on this problem unless effective oral contraceptives are developed and distributed. Conditions in rural India are different from those in the scientifically advanced countries and there is no purpose in hoping that we may be able to stop the present trend in population growth by resorting to the same methods. It is unfortunate that research in the field of development of oral contraceptives has received so little attention in our country. Those, which are available are too expensive for large scale use. Some experiments done in Calcutta have shown that compounds extracted from pea seeds may have the ability to prevent conception. I strongly plead for greater support and interest in promoting research in this field in India. ~~Besides the Indian Council of Medical Research, bodies like the Indian Council of Agricultural Research should also take interest in this problem. If we do not achieve control over population growth, it is futile to expect that we can avoid famines in the near future or that~~ we can bring about a rise in ~~the standard of living of our people~~. The question of population is not only relevant with reference to food production; it is also important from the point of view of denisty per square mile and some American workers have calculated that the world will be transcending the optimum density on the 13th November, 2026. They have called this day "Doomsday".

understanding of genes and the code through which they function would only lead to a further drop in death rate and increase in longevity

if the population explosion would continue

M and
Mendelism & Food Production:

No other science has had as great an impact on food production as genetics. Today man can purposefully manipulate genetic factors in different ways and create new strains of domesticated plants and animals to suit his needs. This is an important development since through the exploitation of suitable genotypes, it is possible to get the maximum advantage from the fertilizer and water applied. Very high yield levels can be reached now by employing a correct combination of variety and cultural practices. The plant breeding work done in India in recent years has led to the release of ~~very~~ high yielding hybrids in maize, jowar and bajra as well as dwarf varieties of wheat and rice which have wide adaptability and a high degree of resistance to the important diseases. ~~Arrangements can be made~~ to multiply the seeds of these varieties and hybrids in adequate quantities and distribute them among the farmers ~~who are in a position to apply~~ the requisite quantities of the different inputs necessary for getting the best out of these ~~new~~ varieties, we can revolutionize our agriculture, as can be inferred from the yields obtained from a 2 crop rotation Contd.....p/4.

as well as from sunlight

If these are cultivated with

such as dwarf wheat - hybrid maize or dwarf wheat - hybrid jowar (Sorghum). In such rotations, over 10 tonnes of grain per hectare ~~have been~~ can easily be harvested in a year. ~~When~~ The production potential of Indian

agriculture is thus enormous. The dramatic increase in yields resulting from the cultivation of the dwarf wheat and rice varieties and hybrids of maize, jowar and bajra has had a deep impact on the minds of farmers and such strains are acting as catalytic agents in the transformation of our agriculture

Modern genetics has helped greatly in manipulating the gene from the point of view of recombination, mutation and function. The theoretical knowledge which is currently being built up in the field of molecular genetics will influence greatly breeding procedures in the near future. The two major goals set for 20th Century biology by Jacques Loeb in 1906 ~~namely~~ viz the artificial synthesis of life and the artificial transmutation of species have been reached in their essentials. There is thus immense scope for increasing food production. However, the application of the necessary inputs on a large scale will require enormous resources. In the United States, while only about 7% of the population is engaged in agriculture, somewhere in the neighbourhood of 60% of the people are involved in business activity related to agriculture. It is important to realise this, since great spurts in production can be brought about only through the wide-spread use of modern technology. It is not difficult to achieve the growth rate of 5% now being aimed at in agriculture, provided the approach to production is an integrated one. If the population grows at the present rate, the increase in food production which we can achieve can still help to feed the growing millions for a decade or two but we we will have to abandon all hopes of raising the standard of living of the people. Immediate action is hence needed in the direction of effective population control and in the extensive cultivation of the high yielding varieties and hybrids which Mendelism has helped to create.

There is no scope for complacency in the field of production research. Already, it is has been observed in some parts of India that when highly productive Jowar hybrids are grown consecutively in the same land for 3 years, there is a great build-up of nematodes, which devastate the crop. ~~There is no way out but to promote good research.~~ New diseases are cropping up resulting from changes in the micro-environment of plants through the application of fertilizers and water promote the growth of crop plants as well as disease-causing organisms.

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MSS:nni

A dynamic research programme is hence a must for sustaining high yields over ~~a long period~~ many years.

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The dwarf plant habit in ~~the~~ rice and wheat ~~are~~ is controlled by single genes and the incorporation of such genes in commercial varieties helps to ~~provide to~~ invest the plant with a morphological frame conducive to its being cultivated under conditions of adequate moisture availability and abundant fertilizer application. The isolation of pollen sterile lines in jowar and bajra enabled the economic production of hybrid seeds and thereby rendered the exploitation of hybrid vigour in them possible. Simple genetic manipulations thus ~~render~~ elevate great spurts in the production potential of the plant. ~~possible~~

The large scale cultivation of the high yielding varieties and hybrids should enable the reduction in the area currently under cereals and millets and the diversion of additional land to the production of fodder and feed. For example, a minimum of 2 tonnes per hectare can be obtained if hybrid jowar strains like C.S.H.1 or C.S.H.2 are grown in conjunction with suitable agronomic practices. AT

Varieties capable of producing the greatest quantity of dry matter per day are now being bred, so that the possibility for producing 2 to 3 crops a year, which is the greatest natural endowment of the tropics and sub-tropics can be fully exploited.

present, this crop occupies nearly 18 million hectares, although the total production of grains is only of the order 9 million tonnes. If should be possible to produce all the Jowar India needs in about 5 million hectares. Thus, there is much scope for evolving new land use patterns and thereby enable the growth of the plant-animal-man food chain. This in turn would help to improve the quality of the food consumed.

Qualitative improvements in cereals and millets can also now be achieved through breeding. The genes causing opaque and floury characters in the kernels of maize were shown two years ago in the United States to double the content of the amino acid lysine in maize. The biological value of the protein was greatly improved by this change in the aminoacid composition. A similar gene has been discovered at the Indian Agricultural Research Institute in a variety of maize from Kashmir (Table 2). Through the artificial induction of mutations, the protein content of some wheat varieties has been raised from 9 to 14 %. and of the rice strain Taichung 65 from 8.5 to 15 %. The scope for the genetic improvement of quality is thus enormous.