PERSPECTIVES IN NEMATODE CONTROL [1]

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Perhaps no other crop protection discipline has gone through as rapid a change since World War II

WORLD POPULATION PROJECTIONS

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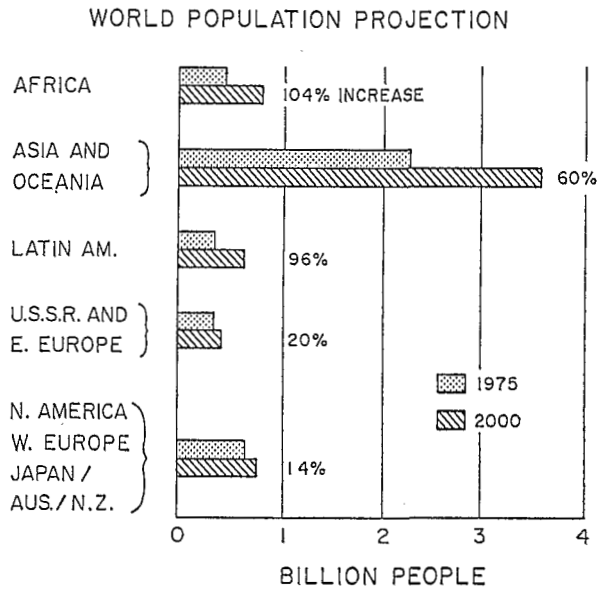

Fig. 2. Projection of the world population by the year 2000 in different areas of the world.

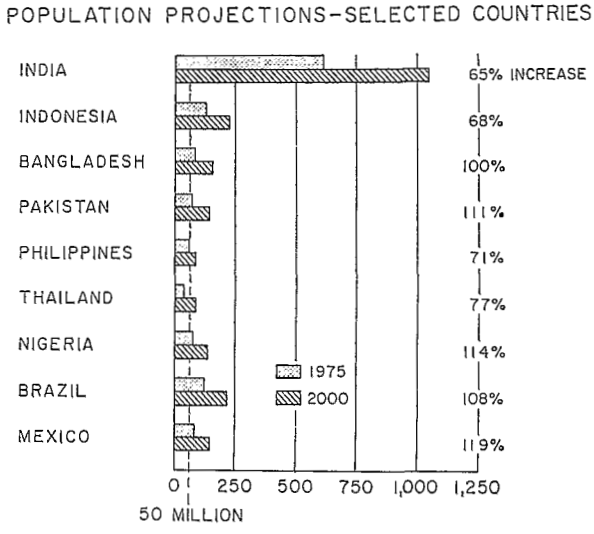

Fig. 3. Projection of populations in tropical countries by the year 2000.

with greater demand for food. Of equal or greater concern than the rapid population increase is the loss of agricultural lands (Brown, 1981 ; Rauschkolb, 1971). In fact, with the rapid utilization of agricultural land for non-agricultural purposes and the degradation of land through erosion, salination, desertification and contamination with pesticides and/or other by-products of civilization, you will note that the actual land available to feed the growing population will be declining not only in absolute hectares but in hectares per capita (Fig. 5). In less developed countries where hectares *per capita* is already less than that in industrialized nations, loss of land for whatever reason in the future will erode their agricultural production potential.

Historically, it has been possible in some tropical areas to solve nematode and other pest problems by essentially abandoning land and going to new sites.

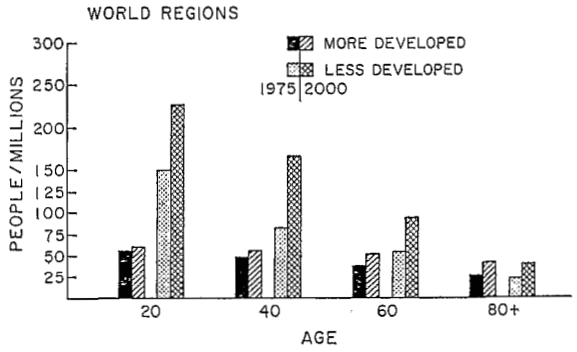

Fig. 4. The change in age structure in more developed and less developed countries from 1975 to 2000.

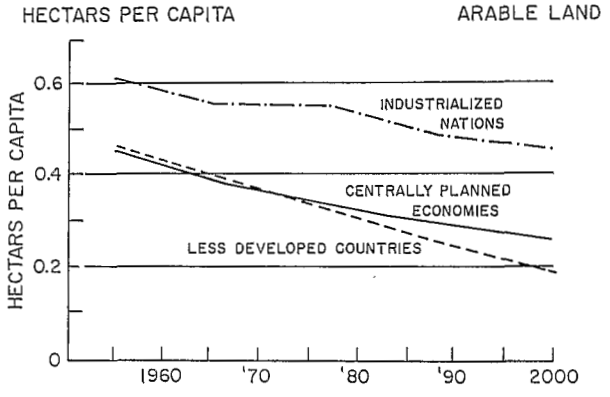

Fig. 5. The amount of arable land (hectares/capita) available for agriculture in industrialized nations, centrally planned economies, and less developed countries.

This is the so-called cut and burn process in which bush and trees in a small wooded area are cut and burned, the land is tilled, and then, as pest problems become insurmountable and the fertility level of the soil declines, the land is abandoned and new land is prepared. This process will not be possible in the future as we come to a more intensive tillage of the soil to provide food for the growing population.

miscible oil formulation is about 40 000 kcal or about 1.3 gal (~ 5.85 l) of oil. Price increases for oil, fuels and several fumigant nematicides (as sold in the U.S.) are shown in Table 2. Although oil increased twenty-six fold in price between 1960 and 1980, the price of petrol (gasoline) and most fumigant nema-

ticides increased only five fold. D-D, by-product of glycerin production, has always been relatively inexpensive compared to other pesticides. However, because of the amount required to treat a hectare of soil, the costs have typically been high (75 to 125 dol-

associated with nematicide use should encourage considerable caution in their widespread use without adequate prior research on their use patterns, stability and mobility in soil profiles.

What are the implications of all of these concerns

Table 3

Countries, number of institutions and nematologists participating in tropical research on nematode problems.

Country	*Number of institutions*	*Number of nematologists*
Australia	1	1
Bangladesh	3	3
Barbados	1	2
Belgium	1	4
Bermuda	1	1
Bolivia	1	1
Brazil	17	21
Columbia	5	7
Costa Rica	7	10
Cuba	2	2
Republic	4	7
Ecuador	7	24
El Salvador	1	3
England	1	2
Ghana	2	2
Guadeloupe	1	2
Guatemala	4	4
Honduras	3	4
Indonesia	1	1
Jamaica	4	5
Ivory Coast	1	5
Malawi	1	2
Malaysia	2	2
Mexico	11	38
New Guinea	1	1
Nicaragua	3	3
Nigeria	12	21
Panama	4	6
Peru	9	10
Philippines	8	26
Senegal	1	5
Somali Dem. Rep.	1	1
South Africa	1	4
Sri Lanka	2	4
Suriname	1	2
Taiwan	4	4
Tanzania	2	2
Thailand	2	3
Trinidad	2	2
Uganda	1	1
Uruguay	1	1
Venezuela	4	24
Viet Nam	1	2
Zimbawe	2	3

has been the impetus for worldwide study of the genetics and biology of the *Meloidogyne* spp.

There has been an increased accumulation of knowledge in the areas of nematode systematics, biology and ecology which is necessary for building effective nematode control programs. The numbers of phytoparasitic nematode genera and species identified from 1950 to 1981 has increased dramatically (Tab. 4). An example of the importance of this information can be noted with the cyst nematodes. In the 1950s the species in the genus *Heterodera* appeared to be adapted to climates found in the northern portion of the north temperate zone. Within the past twenty years, not only have new genera of cyst nematodes been reported (see Tab. 5) but ten new species of this nematode have been found on tropical crops (Luc & Brizuela, 1961 ; Luc & Merny, 1963 ; DeEdwardo & Perry, 1964). Species previously thought to be temperate have been found in more tropical or sub-

Table 4

Increase in plant parasitic nematode genera and species from 1950 to 1981 .

	1950	*1981*	*Gain*
Genera	29	143	114
Species	192	2 653	2 461

Courtesy of R. K. Esser and K. J. Warkcom.

Table 5

Number of *Globodera, Punctodera,* and *Heterodera* species in 1950 and 1980

	1950	*1980*	*No. of tropical species*
Globodera	0	7	2

[redacted]

of plant pathogenic nematodes. However, the largest quantities of chemicals were used in industrialized countries. Where they were used in the underdeveloped tropical and subtropical countries, they were used primarily to combat nematodes attacking plantation crops, such as banana, citrus, pineapple and sugarcane, or small plantings of high value crops, such as tobacco. Aside from the coasts, another major limitation on the use of fumigant nematicides is the more sophisticated technology required to place them properly in the soil at the right dosage/ha.

The introduction of granular organophosphate and carbamate nematicides in the 1960s and 1970s provided active chemicals that could be applied by hand or by simple machines. Granular formulations were attractive because many farmers did not have water close at hand to use as a solvent/carrier for liquid formulations of nematicides. The new chemicals were low in phytotoxicity and could be applied at planting or to soil around established plants. Again their widest use was in plantation agriculture but when used as a planting hill or row treatment their use could be extended to crops returning less profit per acre. Human toxicity became a real danger and

world. Remarkable yield increases have occured on a wide range of crops.

In India application of granular organophosphate or carbamate nematicides to corn at planting time has provided effective nematode control (Seshadri, 1981). In isolated cases, the control of tylenchid nematodes at the beginning of the growing season using carbofuran increased yields up to 200 percent.

A recent report from Australia (Brown, Pye & Stratford, 1982) indicated that EDB and Terbufos had been registered for commercial use to control cereal cyst nematode, *Heterodera avenae*, in wheat. Some 2 million ha are infested in Victoria and South Australia. Liquid formulations of EDB are injected in the seed row with a special pump or granular formulations of Terfuros are placed in the seed row through a small box attached to the drill. At the present price of wheat it was estimated that an increase of only 102 kilograms/ha of grain was required to pay for the chemical. Thus we are looking at a situation where a nematicide applied by special techniques might be profitably used on a crop of relatively low per hectare value.

In the developing areas of the world money to

tactics to achieve acceptable plant growth and yield, whereas the single tactic approach might either fail immediately or have a short tenure in the agroecosystem under study. Crop rotations, where feasible, will play a key role in suppressing nematodes in crops of low market value. Crop rotation requires an exhaustive knowledge of nematode taxonomy, speciation, and host/parasite interactions. In addition, one must know how nematode reproduction, population increase and survival are affected by edaphic factors. In many situations a close study of nematode response to soil texture and moisture, coupled with a knowledge of host cultivar ,, tolerance '' can lead to the use of cultivars that will remain productive when planted on non-nematode conducive soil. The status of the soil can be improved relative to damage

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