The Present Status of Milk Production and Applicable Criteria Conducive to Its Amelioration in Under-Producing Countries

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Mr. President, Ladies and Gentlemen,

When my friend and colleague, our Congress President Dr. Rene Dubois advised me of the Scientific and Organising committee's decision to invite me to travel this long distance in order to present one of the key lectures at this event, I felt and still feel deeply honoured. I would like to take this opportunity to thank them for this high distinction.

All protein of animal origin for human consumption (excluding fish and seafood) is produced by 1225 million bovines, 1600 million (m) sheep and goats, 780 m porks and 6600 m poultry. (1)

Of the world's bovines, Asia holds 372 m heads (30.36%); South America (S.A.) 213 m (17.4%); North America 162 m. (13.2%); Africa 174 m (14.2%), Europe 133m (10.85%), the USSR 117 m (9.6%), Oceania 30 m (2.45%) and Central America 22m (1.8%)). (2)

Dairy cattle (228.6 m head), make up 18.7% of the world's bovine population, (2) and produced 431 m metric tons of milk (3) in 1983 (Figure 1).

FIGURE 1. The balance of animal and vegetable protein (average gram consumption per caput per day) in various countries.

Country	Animal Protein	Vegetable Protein	Total
North America	70.7	27.5	98.2
Australia & New Zealand	63.4	31.0	94.4
Argentina, Paraguay & Uruguay	57.4	36.6	94.0
Western Europe	48.5	39.7	88.2
Eastern Europe	35.8	55.1	90.9
USSR	35.6	56.6	92.2
Japan	31.8	45.1	76.9
Latin America & Caribbean	22.8	35.2	58.0
Near East	12.2	53.7	65.9
Africa	12.1	48.9	61.0
China	8.8	47.8	56.6
South Asia	6.3	42.5	48.8

Keynote lecture delivered at the opening session of the 2nd Pan American Congress on Milk Production, Sao Paulo, Brazil, May 13-17, 1985.

The division and distribution of bovines and dairy cows on the American continent is as follows (Table 1) (2).

As we all know, these numbers are from many points of view meaningless. The 362 m heads of cattle in Asia, making up 30% of the world's bovines, produce but 7.9% of it's meat, and 7% of the world's milk, while 21.2% of the world's dairy cattle held by the Western World, produce 52.6% of its entire milk. (Table 2).

With Europe (excluding the Soviet Union) holding but 11% (133.069.000) of the world's bovines, produces 42% of its entire milk.

Per capita protein consumption ranges from 98.2 gr/day in the USA, of which 70.7 grams is of animal origin, to 48.8 grams and 6.3 grams respectively in Southern Asia (4). (Figure 2).

According to the FAO estimates for the early 80's, 500 m people consume daily rations inferior to the critical minimal limit (the World Bank figure for 1980 is 780 m). The figure for Latin America (L.A.) is 41 m or 13%. (5)

TABLE 1. Cattle Population (thousands)

		Cattle (total)	Dairy Cows
WORLD		1.226.552	228.608
AMERICA	NORTH	162.719	22.690
	Canada	11.598	2.590
	Mexico	36.000	9.100
	U.S.A.	115.121	11.000
	CENTRAL	22.479	3.154
	SOUTH	212.831	24.398
	Argentina	53.670	3.000
	Bolivia	4.200	55
	Brazil	93.000	14.700
	Chile	3.865	700
	Colombia	24.275	2.700
	Ecuador	3.000	700
	Malvinas	8	1
	Fr. Guyana	12	
	Guyana	310	20
	Paraguay	5.600	92
	Peru	3.204	680
	Suriname	53	6
	Uruguay	10.308	530
	Venezuela	11.326	1214

(FAO 1983)

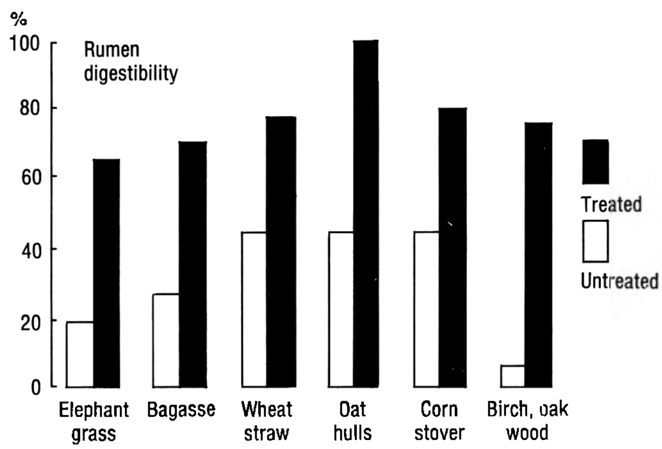
TABLE 2. Milk Production (3)

WORLD	431.849.000	Tons	
WESTERN WORLD	227.400.000	Tons	52.6%
W. EUROPE	135.083.000	Tons	
U.S.A.	63.488.000	Tons	
Canada	8.053.000	Tons	
Australia	5.559.000	Tons	
New Zealand	6.062.000	Tons	
Japan	6.625.000	Tons	
South Africa	2.530.000	Tons	

The real world situation looks as follows:

	World	Western World	%
Population	4.670.000.000	749.000.000	16%
Cattle	1.226.552.000	262.492.000	21.3%
Dairy Cattle	228.608.000	48.600.000	21.2%
Milk Production (T)	431.849.000	227.400.000	52.6%

FIGURE 2. Increase of rumen digestibility by steaming and extraction.



(from Puls and Dietrich, 1981)

Hunger can be eliminated only by adequate animal protein and grain production. In order to produce animal protein efficiently, certain amounts of grain are needed. A dilemma thus seems to exist.

In order to understand the present conditions, we must look back at the main events creating them.

Before the crash in 1929 in the USA, 4.500.000 farmers there kept 21.618.000 dairy cows (average herd size 4.8 head).

At the peak of World War II's agricultural production effort in 1944, 3.656.714 farmers kept 25.597.000 heads of dairy cattle in herds of 7 heads.

In Europe almost the entire agricultural infrastructure was destroyed by war and the U.S. went into overproduction to cover the needs of the Marshall Foreign Aid Programme. By 1950 about 2.500.000 farmers milked 28.945.000 dairy cows (37.1% of its entire cattle population) average size of dairy herds growing.

The relatively rapid reconstruction of European agriculture left the USA stranded with mountains of milk powder and butter. The US government ceased guaranteeing and subsidizing milk prices, recreating a free market, and distributed its accumulated excess of milk and butter, as foreign aid free of charge, to countries in need.

In 1978 only 379.530 dairy farms remained, milking only 10.848.000 cows in herds averaging 28.6 head.

5 years later (1983), 11 m dairy cows, out of 115.121.000 bovines, (9.55%) produce 63.488.000 tons of milk with an average of 5586.5 kg/milk/cow/year almost entirely for the local market. (6).

TABLE 3. Development of Dairy Farming in the U.S.A.

Year	No. Bovines	No. Dairy Cows	%	No. Dairy Herds	Herd Size
1929		21.618.000		4.499.375	4.8
1944		25.597.000		3.656.714	7.0
1950	77.963.000	28.945.000	37.1%	2.500.000	11.6
1978	110.864.000	10.848.000	10. %	379.530	28.6
1983	115.121.000	11.026.000	9.6%	288.276	38.25

6, 7, & Crane, 1979; cit. by Goodger et al. (1982)

As a direct result of the 1973 oil crisis, most countries were forced to severely limit their imports of agricultural products, mainly meat. Exports of meat from Latin American countries alone dropped from 26.66% of the entire world market in 1970 to but 9.03% in 1975; (Asia from 13.53% to 0.08% in 1975).

The European Countries kept up their policy of subsidizing agriculture in general and the intensification of milk production in spite of the oil crisis. Unable to continue selling their milk products, they were now stranded with mountains of milk-powder and butter, partly distributed to Developing Countries in need, mostly sold at a severe loss on the World market. Composed of many countries, it took the EEC several expensive years to finally reach an agreement, introducing in some cases rather draconic production quotas. As in the case of the USA in the late 50's, by 1990 overproduction of milk in Europe will be curtailed and the price of milk powder and butter on the World market will regain its real value.

At those prices few will be able to afford the import of milk powder and butter nor will anybody be able to continue donating them, except in extreme cases like Cambodia, Biafra and Ethiopia.

To conclude this short introduction permit me to underline the following:

1) Since the oil price squeeze in 1973, the industrialised countries are rich no more. They are at long last beginning to realize it.
2) Milk, basic meat and grain prices are government determined and controlled.
3) The mountains of butter and milk powder dumped on the World market are therefore the direct result of faulty

government planning and policy.

4) A strict milk production quota has now been introduced in all overproducing countries. Excess stocks will slowly disappear and World prices return to normal.
5) For many reasons all countries remain interested in keeping and even increasing their rural populations in order to ensure their own food supply, mainly fresh milk.
6) Intensity of milk production is dictated by geophysical considerations. New Zealand, blessed with abundant pasture, feeds no concentrates, but has nevertheless a medium milk production average due to an excellent genetic scheme. Israel, having no pasture, a penury of water and a hot climate, has devoted half a century to produce a high yielding, climate adapted cow, always labouring under a strict quota of both milk and water (thus low roughage content ration).
7) Thus, government and/or geophysical considerations determine milk production policies and its economics, and it is within these confines that we have to find and apply the best practical solutions.

This is a Pan-American Congress on Milk, but my subject deals with the problems of under-producing countries. Permit me, therefore, to eliminate from further discussion the fully producing countries, Canada and the U.S.A., by stating that peaks in both agricultural and milk production have been attained there. The yearly loss of land to urbanisation, 1/2 m acres in the US alone, coupled with an almost zero population increase, will enable them to remain self-supporting through intensification and to produce for export if, and, whenever needed.

The U.S. is in the midst of a process of converting to large units, which are both more economical and achieve higher milk averages. (Table 4).

TABLE 4. Herd size averages in the U.S. in 1983.

Cows Per Herd	Percent of all Dairy Cows	No. of Herds	% of all Herds
Above 100	35% (3.9 m)	19.700	6.8%
50 - 99	32.8% (3.6 m)	35.275	12.2%
30 - 49	21% (2.3 m)	66.261	23.0%
Below 29	11% (1.2 m)	167.040	58.0%

Except for the danger of "imported" infectious diseases and newly emanating ones (like myco and other toxicoses), the main problems of Canada and the U.S. will be those of production and management diseases.

The L.A. countries are facing a serious problem of both population growth and of migration into urban areas, but have on the other hand a capacity to increase agricultural production by 46% through intensification and irrigation, as well as the possibility to increase existing arable land by 73% (5) (according to the F.A.O.).

They are severely handicapped by a milk production performance average of 1028 kg/milk/cow/year in 1982, almost 50 kg less than 8 years before their dairy cows making up 13.5% of their entire cattle population.

I feel duty bound to stop here in order to state the following: I have never set foot on the South or Central American sub-continents before, and have paid but two short professional visits to Mexico. When our host Dr. Dubois proposed me for this lecture, I told him that in view of the above I considered myself the person least suited to analyse and advise on the problem of L.A.'s under production of milk.

His answer was unexpected to say the least, but as you see very convincing: "We have conducted many local, regional, national and subcontinental analyses, both general and specific. We do not need another one. WE KNOW where, why, and what is wrong. We want you, mon ami, BECAUSE you know nothing about our problems and conditions and because you come from a country where conditions were much worse when 65 years ago you produced an average of less than 500 kg/milk/cow/year. Every expert consulted maintained that no milk production effort could possibly ever succeed there for the following reasons: indigenous cattle with a very low genetic potential, a hot climate, subtropical in some, desert in other areas, a short rainy season, a severe penury of water, lack of natural pasture, while the herd was infected by almost every known type of infectious disease, all types of tick borne fevers and gastro-intestinal parasites. Less than 35 years later and about 30 years ago, you broke the world record of milk production and kept it ever since. The result of the large scale FAO experiment in Poland have demonstrated the high genetic value you have attained.

We in L.A. have to increase our milk production. We want you to draw conclusions from your achievements and experience, and advise us on what is or can be practically applicable here. You have made your mistakes, paid their price and studied them. Help us to avoid them and thus save both money but above all time."

Well Rene, here goes:

The two main factors determining economic success in milk production are: 1) Milk production of the individual cow (both averages obtained and top genetic capacity).

2) Management: a. Nutrition; b. Cost: mainly labour.

Milk production is the direct result of genetic potential, correct feeding, climate, an optimal intercalving period (in most cases 1 calving per year), a production span of 3-5 lactations (depending on herd production averages), persistency in lactation, and obviously health.

I have, last year, defined the tasks before us in developing milk production in underproducing countries as follows:

a. Upgrade production capacity and disease resistance,

b. Introduce production oriented management systems,

c. Improve microbiological and parasitological disease control and eradication.

All I shall say here about disease is that a healthy stock is the self evident basis for all endeavours to increase milk production.

Another subject I shall not go into is that of the economic aspects involved, neither basic investments nor running expenses like cost of labour, energy, loan repayment etc.

We have a low milk production average per cow in L.A. In the only country I know here, Mexico; statistics say that 9.100.000 cows produced 6.924.000 tons of milk, or an average of 760 kg/milk/cow/year. I have personally had the pleasure of visiting dairy farms in Mexico producing averages of 4.5 and even 6000 kg/milk/cow/year. I know that such farms exists in almost every L.A. country. Therefore high milk production averages can, and have been achieved and maintained.

There is one cardinal point that has to be clarified here and now. Changing a country's milk production pattern demands time and serious large scale and long term investments. Only governments can decide and guarantee these.

The subject, therefore, has to get a high priority rating in each government's development plans.

A market for milk and dairy products must not only definitely exist, but the buying power to acquire these products must be either available, or assured by a predetermined government subsidy plan. Otherwise every effort to upgrade existing or create new dairy farms is doomed to failure.

There exists no problem in founding any number of high producing dairy farms anywhere, provided the climate is suitable. 15.000 Israeli dairy heifers exported to 3 specially created farms near Tehran, have produced averages of above 7000 kg per cow per year, for over 10 years (till Homeini took over). This covered the needs of an existing international market in Tehran, but did nothing to improve milk production averages in Iran, nor was the local population able to afford it as a regular component of their daily ration.

The question all of you here present have to ask yourselves, and answer is the following:

Is not the existing low production rate, out of many millions of good, imported dairy breeds in Latin America, the direct result of a non existing market, or one incapable of paying?

Is not the impossibility to derive a reasonable income from milk produced, the reason for not feeding concentrates and grain, which seems the only possible cause for your low production out of relatively good stock?

I'll be even more provocative: If a big market does indeed exist, and if your low production were indeed the only reason for low milk sales, how do you explain the fact that in spite of the EEC dumping prices of milk powder and butter on the world market this is what actually happened:

Argentina bought no milk or butter. Nor did Uruguay, they exported!

Brasil bought no butter, 10.000 tons of milk powder in 1982, and 25.000 tons each in 1983 and 1984.

Chile: 3, 12 and 15.000 tons respectively,

Peru: 30, 45 and 22.000 tons respectively and

Venezuela: 6, 8 and 8.000 tons in 1982, 3 and 4. Total milk powder imports to S.A. were in 1982, 53664 tons and in 1983, 65745 tons (3) only!

Had that market really existed, or rather had the buying power existed, why were not hundreds of thousands of tons of milk powder and butter bought cheaply at 1/6th of their world market value (EEC dumping prices) and sold by the various governments at a large profit, moneys that could have been used to finance the upgrading of your own milk production?

The best possible conclusion I can draw is that the market does exist potentially, but the additional clients needing the milk are at present unable to pay for it.

As that is most probably the case, I beg you herewith: Please do not apply any of the advice others and I shall give you here, unless and until each government concerned will be able to furnish the necessary safeguards and guarantees to ensure that all additional milk produced can be marketed with a predetermined profit margin to the producer, over and above the loan repayment scheme and the increased production costs. Otherwise the producer will once again cut protein and energy supply to his cattle in order to finance his losses.

Sorry to be so blunt, but this is the only possible logical conclusion to be drawn from the fact that a sub-continent so admirably suited to cattle husbandry, which has imported so many heads of good dairy breeds, produces so little.

Having stated what I believe to be the major problem which can be solved only in each country concerned, here is what we now face:

PROBLEM: Underproduction of milk. 24.400.000 dairy cows producing an average of but 1028 kg annually in S.A.; and 12.500.000 additional ones in Mexico and C.A. (CA = Central America) producing even less.

AIM: To increase average milk production in all L.A. countries.

BASIS: The existing local dairy herds.

LIMITATION: time and financing.

REALISATION: Determine general guidelines and principles. These are to be adapted specifically to each country according to conditions prevailing, and to objectives determined and defined there.

SUPPORT: Internationally accumulated knowledge and knowhow, specific target oriented applicable research.

The Herd

According to reliable estimates, out of 36.652.000 dairy cows in L.A., 4 m are of imported dairy breed origins, mainly Holsteins-Friesians. There are about 1 m in Mexico, 700.000 in Brasil, including Holstein-Gir crosses. Some of these are kept in well managed intensive herds producing 5-6.000 kgs. Others are kept extensively on improved pasture, like the 160.000 of Peru, producing 2.200-2.400 kg averages. Most of them have been degraded into what you define as "Doble Proposito" or double purpose cows, suckled by their calves till drying off, milked once a day and thus producing marketable averages of but 1½-3½ kgs a day.

Nutrition

Permit me to underline a few facts:

1) The cow is a ruminant, can digest cellulose and utilise non protein nitrogen (NPN).

2) Cellulose is the most abundant organic product on earth. It is estimated that for each person alive, 70 kg of cellulose waste are produced each day.

3) Ruminants are the only major class of animals that can metabolize cellulose to produce energy.

4) Over 60% of the available land is suitable for grazing only, producing forage valuable to humans only through livestock production (9). In addition, for every kg of rice, wheat, corn or sorghum produced, there is at least 1 kg of other plant products, mostly cellulose, that is potentially usable only by ruminants. If only 5% of the total cellulose waste could be processed, it would provide sufficient dietary energy to produce the world's protein needs. (10) Cereal straw production in Asia totals 600 m tons a year, in South America and Africa, 200 m tons. Banana, cassava, citrus fruit and coffee residues in Latin America, Asia and Africa equal 124 m. tons; sugar cane residues: 83 m. tons. Available for animal foods are 40% of all root and tuber crops, 60% of all grain crops, 85% of all oilseed crops and 90% of all sugar crops (10) as well as excess and waste of fruit and vegetable production. (Fig. 3; Table 4a)

5) Animal wastes: Cattle manure can be an important ingredient, mainly in ensiled form, a high % in the ration can be fed with no ill effects. We feed broiler manure to beef cattle, and an ensilaged one to heifer calves, late lactation and dry cows. Algae, containing 45-65% crude protein are easily grown on human and animal waste waters and dried for fodder (10). For every kg. of broiler meat produced (Pollo d'engorde), ½ kg. of 80% dry manure is excreted, while laying hens produce 6 kg. a year.

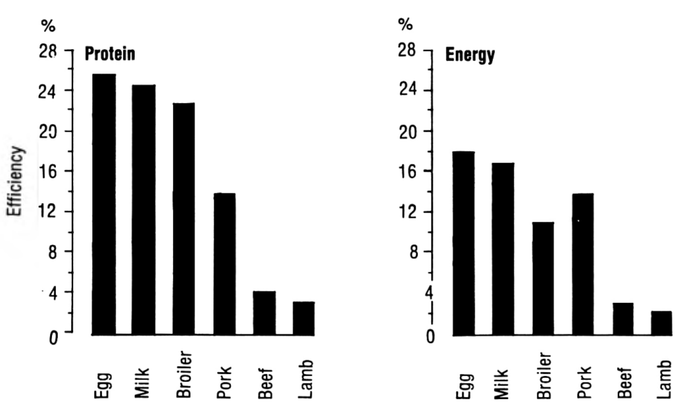
6) The efficiency of conversion of plant protein and energy to animal protein is only 22-25% for milk, eggs and poultry, and for ruminant meat only 5%. (Figure 4). In order to produce animal protein efficiently, certain amounts of grain and/or other sources of energy and protein are needed.

These two facts are willfully misrepresented by an ever growing and ever more aggressive and vociferous lobby, aided by a certain type of irresponsible press, mainly in Europe, demanding that feeding of grain to animals be forbidden while children starve.

7) The question we must therefore ask ourselves is not how much plant protein and energy is fed in order to produce high grade animal protein, but how much human edible protein (HEP) is fed, and how big is the return?

8) Efficiency of food conversion in the cow increases with high production of both meat by 8% (Figure 5 (11) and of

FIGURE 3. Efficiency of livestock measures the percentage of dietary crude protein and energy converted to products edible by man.



V. Englehardt et al. (1)

TABLE 4a. By-products and wastes useful in animal diets.

Plant products		Animal products	Industrial products
Alfalfa leaf meal	Linseed meal	Blood meal	Brewers dried
Alfalfa meal	Malt sprouts	Feather meal	grains
Apple pomace	Mustard wastes	Hydrolyzed	Brewers malt,
Bananas	Navy beans,	hog hair	dried
Banana stems	cull	Intestine	Distillers
Bagasse	Oat hulls	contents	dried grains
Barley hulls	Oat groats	Liver meal	Distillers dry
Pearl barley	Oat meal	Manure	solubles
by-product	Oat straw	Meat meal	Animal fats
Beet tops	Olive cake	Meat and	Vegetable fats
Beet pulp	Peas, cull	bone meal	Hydrolyzed fats
Buckwheat	Peanut meal	Meat meal	Fennentation
middlings	Peanut hulls	tankage	extract
Cassava leaves	Peanut skins	Meat and bone	Fennentation
Cassava pellets	Pineapple bran	meal tankage	product
Citrus pulp	Pineapple pulp	Poultry by-	Fennentation
Citrus seed	Potato products	product meal	solubles
meal	Ramie	Poultry hatchery	Bakery products
Coconut meal	Rice bran	by-product	Garbage
Corn germ meal	Rice mill	Slaughterhouse	Coffee wastes
Corn gluten	by-products	offal	Leather meal
meal	Rice polishings	Urea	Molasses
Corn grits	Single cell		Beet
Corn cobs	proteins	**Marine products**	Cane
Corn stalks	Soybean hulls	Crab meal	Citrus
Cottonseed	Soybean meal	Fish meal	Wood
meal	Sugarcane tops	Fish solubles	Newspaper
Cottonseed hulls	Safflower meal	Fish silage	Sawdust
Grain sorghum	Sunflower meal	Shrimp meal	
Grain sorghum	Sunflower hulls		
gluten meal	Tree pods	**Milk products**	
Grain sorghum	Tree parts	Buttermilk, dried	
grits	Tomato skins	Skimmed milk,	
Grain sorghum	Wheat bran	dried	
stalks	Wheat germ	Whey, dried	
Grain	meal	Whey product,	
screenings	Wheat middlings	dried	
Grapeseed meal	Wheat red-dog		
Guar meal	Wheat shorts		
Kapok and	Wheat straw		
shea nuts	Yeasts		

milk (expressed in grams of protein by Mcal of digestible energy) (Figure 6). There is a 10.5% efficiency at 3600 kg. of milk produced on pasture alone, and a 20.5% one at 13.000 kg. on 65% concentrates (12).

9) For milk production an input of but 15.9% HEP gives a return of 181%, an elevenfold increase in HEP, for bovine meat production, an input of but 4.9% HEP, yields 109%, a twenty-two fold HEP increase, the ruminant performing much better than pork (86%) and poultry (75%). (Figure 7). (13)

FIGURE 4. Efficiency with which cattle produce milk protein.

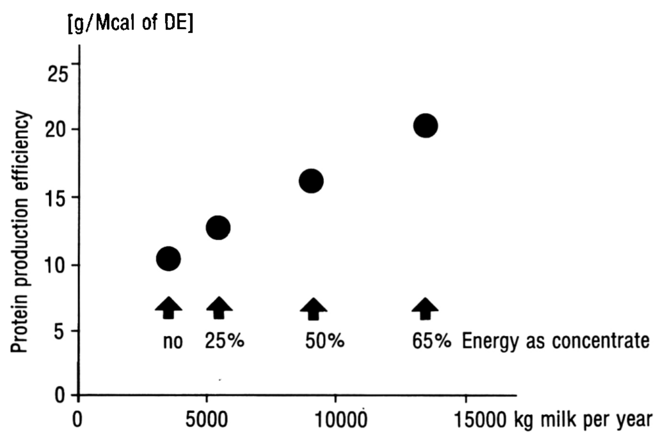
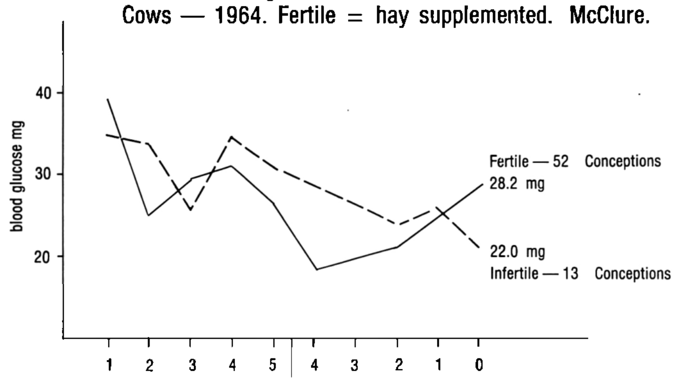


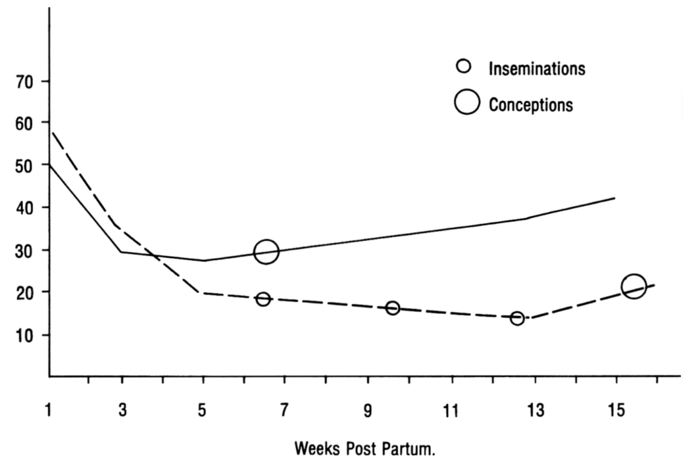
FIGURE 5. Weeks after partum before mating.
Mean blood — glucose levels of fertile and infertile.
Cows — 1964. Fertile = hay supplemented. McClure.



To paraphrase Professor v. Engelhardt, we can thus not only eat our steaks and drink our milk, but do so with a clear conscience.

10) A cow can consume but up to 3½% of her weight in dry matter (DM) each day. This means about 15 kg of DM for a 500 kg cow, or 21 kg for a 650 kg one. This physiological limitation has to be exploited to its very utmost in high producing animals, by heavily enriching the ration with grain and proteins, and choosing roughage of high quality and digestibility. In California's high yielding herds, 60% of concentrates are fed and 40% of exceptionally high grade roughage. In Israel, not having the water to produce these

FIGURE 6. Inseminations and Conceptions on body weight curves. (Kalj, Amir, Shapira).



large amounts of roughage, we were forced to select for better metabolisation capacity of grain, permitting us to feed 70-75% concentrates during the high producing phase of the lactation.

On pasture alone, volume playing a role as well as lower digestibility of roughage, only 2.7% of body weight in DM can effectively be consumed. On the very best pasture (improved) in New Zealand, with a 1.4 Mcal/NE/lact per kg of DM, 21½ Mcal can be fed, which, subtracting needs for body maintenance (8.6 Mcal) leave 13 Mcal for milk production, yielding about 3200 kg per annum with peaks of 3.600. On lower quality pasture having a higher fibre and lignin content, consumption may drop to 2.2-2.5% of bodyweight in DM and energy content to 0.9-1.2 Mcal/NE.

11) A dairy cow needs about 3150 Mcal of energy for body maintenance a year and only 700 Mcal to produce 1000 kg of milk, which is more or less S.A.'s declared average production.

12) Normal pasture, with an acceptable fibre content roughage, provides fodder to produce 1500-2000 kg of milk.

13) A simple analysis shows that the average so called "Dual Purpose" cow produces not 500 but at least 1200 kg of milk per year, milk that never reaches the market because the calf is not removed and the cow is milked only once a day.

14) For calf rearing purposes, 1 kg of concentrates (average price in L.A. 25 US¢) has the nutritive value of 4 kgs of milk, and provides higher levels of protein. The replaced 4 kgs of milk sell for 60-120¢ (according to country) on the farm. (A profit of 35-95¢ a day).

Removing the calf either after collostrum—feeding milk replacers, or after 2 months (a waste)—feeding concentrates, would triple the amount of milk marketed and thus the derived income.

15) Pasture can and should be improved by: a) replacing wherever necessary existing gramineae by others having both a higher nutritive value and a lower fibre content, thus higher digestibility; b) introducing wherever possible, perennial locally suited leguminous species. Graminees have

the double drawback of a low energy and a low protein content.

Studies to determine the plant species best suited to bovines must be carried out in each country and for each geophysically different region.

On pasture, a good animal carrying balance must be maintained, animals moved regularly to avoid overgrazing, and fertilization applied according to need. Laboratory pasture analyses should be carried out regularly in order to determine its values (for energy and protein as well as for minerals and trace elements) to dictate necessary supplementation.

16) "Non conventional feeds" from the above list, available locally (from vegetable wastes & broiler manure to urea and molasses) should be added (after determination of their nutritive values and in the exact quantities prescribed). The additional milk produced will permit the financing of the complements of grain or concentrates needed to enhance higher production.

17) Through the introduction of the Israeli Extension Services, of only pasture improvement (point 15) and the lowering of the percentage of dry cows in 454 dairy herds in the Dominican Republic, the ENTIRE milk production average in this country was increased by 32% in only 14 months.

This introduces us logically to the second major cause of low milk production in L.A.

Reproduction

Instead of a 12-13 month calving interval, we have a 16-17 month one, and instead of 18-22% of cows dry in the herd, we face a 35-40% dry cow average.

In addition to the loss of calves and milk thus caused, a long intercalving period imposes a rotation through the seasons of the year. Therefore instead of permitting us to plan and guide conception and calving to the most suitable seasons both pasture and climate wise, which may differ greatly from region to region, we are forced into seasons showing lower conception rates (for climatic or nutritional reasons), thus increasing herd infertility and dry cow numbers, perpetuating a vicious circle.

Parturition imposes a post-partum (p.p.) production stress on dairy cows whatever their genetic potential. Within 2-3 weeks, p.p. cows reach their top production level. The physiological limitations of DM consumption forces cows post p. to mobilize energy and protein through lipo and proteinolysis of their body tissues. They thus lose weight and a serious drop in blood glucose levels occurs. McClure (14) showed that during this weight loss conception rates dropped to about 13% (Figure 8). The group supplied additional energy, reversed the process, 52% conceptions were recorded and a 28.2 mg% blood glucose level reached. An Israeli experiment shows that during weight loss conception is almost nil (Figure 9).

In intensively reared, high producing dairy herds, the problem of weight loss p.p. is seriously enhanced by the physiological incapacity of these cows to ingest more than 14 kg of DM p.p. reaching their top consumption capacity only after 6-10 weeks (21 kg DM for a 650 kg cow), while reaching top level production 2-3 weeks post partum. The rations fed these cows contain the highest energy and protein levels they can digest and cannot therefore be enriched any further.

Based on observations made by me, I have stated in 1978 in Mexico (15) and have provided absolute proof since (16, 17, 18, 19, 20), that the cause of this incapacity in high producing dairy cows to ingest the normal 3% of body weight in DM, is caused by the degeneration of the ruminal papillae during the dry period, due to nutritional changes, and their body slows regeneration.

In low and average producing dairy cows reared on pasture alone, or with but little added energy, this extreme degeneration does not seem to occur, as no nutritional changes do occur during the dry period. We can therefore enrich their p.p. ration by the supply of additional energy and protein needed to achieve their top production capacity. The top production caused weight loss can thus be avoided or limited, and normal conception capacity resumed 50-60 days p.p., as proved by McClure in cows on pasture. (14)

In order to take advantage of the capacity for normal conception 2 months p.p. thus created, artificial insemination (A.I.) must be introduced.

I do not think that I have to waste precious time to extol the merits and advantages of using A.I. instead of bulls before this august audience, without even mentioning the importance of A.I. as a means to improving the genetic potential of the national herd.

The reference to better and less suited seasons for production and reproduction, introduces the third major cause of low production:

Hot Climate

It adversely influences production both directly by reducing ingestion and indirectly by negatively affecting reproduction.

The digestive process, mainly in ruminants, creates heat.

Non-producing dairy cows (dry cows and heifers) fed only for body and foetus maintenance, are able to radiate that heat even under adverse climatic conditions. Cows ingesting additional fodder for milk production, can get rid of excess heat in temperate climates.

excess heat becomes impossible and the body t° of cows rises by up to 1½ and even 2° Celsius in extreme cases (40.5°-41°C).

Exposure to direct solar radiation through lack of shade during the hot hours (as measured by us with normal and black globe thermometers (21)), can increase environmental heat stress by up to 10°C.

Whereas in Europe, dairy cows react adversely to t° above 23°C, Holsteins in hot U.S. regions (Arizona, Nevada) and

Israel, do so only at t° above 28-29°C. Through the systematic culling of low producing and infertile cows for selection purposes, we automatically eliminated all cows adversely reacting to heat stress by lowering production and fertility. We thus indirectly selected for heat resistant animals for over 60 years, as has been done in the hot areas in the U.S. (Arizona, California, Nevada etc.)

The fact that their offspring show the same adaptation capacity permits us to assume that heat resistance is an acquired hereditary trait.

The defense of milk producing cows to heat stress and the ensuing rise in body t° is to limit DM intake, thus lowering milk production. (High energy containing, easily digestible rations must therefore be provided during the hot season).

Humidity as well as high atmospheric pressure increases heat stress. Regions showing a THI (Temperature Humidity Index) of 75 and above, show a consistently lower milk production average, whereas cows in even very hot drier areas, blessed with cool nights permitting heat discharge and recuperation, are capable of producing top records of well above 10.000 kgs. In Table 5, I compare the average milk production of 10 states situated around the Gulf of Mexico and along the Mississippi valley, having a hot humid high THI climate, some of them a high year round atmospheric pressure (30.1-30.2) with that of 3 hot, low THI states. The difference is of above 2000 kg/cow. (Texas is not really typical, having normal THI values in the large North/West).

The two interesting states are those of Florida and California. Both are blessed with a high level agriculture. Both have almost 100% industrial sized dairy herds, and have a very high standard of management. Both milk the same type of cow with identical milking machines and techniques, feeding them according to the highest scientific criteria. If anything I would venture the statement that Florida has invested more in trying to get their cows to produce under their climatically inferior conditions. They have achieved a 5038 kg average production, 2000 kgs less than California.

The one lesson L.A. should learn from this table is that upon deciding to create new milk producing areas, they should choose those best suited climatically to milk production and never permit political or electoral pressures to influence their choice.

The fertility of dairy cows is adversely affected by high ambient t°s and the resultant heat stress.

The use of frozen spring time semen of highly fertile bulls during hot seasons, and the very low conception rates obtained, compared to those of temperate seasons, proves it.

Studies conducted in Israel (22) recently show:

1) A significant, 23% reduction in blood flow occurred during hyperthermia in the ovaries of all animals, and a 37% one in the undifferentiated uterine wall of both non-pregnant and early pregnant animals. The reduction in ovarian blood flow during heat stress was most prominent in early gestation, the effect subsiding with advancing gestation.

TABLE 5. Average Milk Production in 1982.

State	No. of Dairy Cows	Average Milk Production (kg/year)
Alabama	59.000	4459
Arkansas	85.000	4381
Florida	190.000	5038
Georgia	131.000	4898
Kentucky	241.000	4449
Louisiana	102.000	4269
Mississippi	96.000	4252
Oklahoma	111.000	4760
Tennessee	216.000	4744
Texas	329.000	5198
TOTAL	1.560.000	4752
Arizona	81.000	6787
California	940.000	7006
Nevada	166.000	6379
TOTAL	1.037.000	6979
U.S.A.	11.026.000	5586.5

Florida: 98.8% of Dairy Cows in herds milking above 100 head.
California: 96% of Dairy Cows in herds milking above 100 head.

2) Plasma progesterone levels were significantly reduced in all animals during heat stress, the reduction being related to the degree of body t° increase. During heat stress, the peripheral progesterone levels were correlated with ovarian blood flow.

In Israel, we shower all cows in milk 3 times a day (using overhead and floor spray nozzles) before entering the milking parlour, drying them by forced ventilation air flow. This lowers body t° by over 0.5°C, and increases milk production and conception rates. A 2 year experiment just concluded (23), of repetitive cycles of wetting the coats followed by forced ventilation, was highly successful in preventing the diurnal increase in body t° and increased milk production significantly.

In addition to these two heat-induced causes of depressed fertility, the lowered ovarian and uterine blood flow and lowered plasma progesterone levels, both adversely influencing the nidation process; there is evidence that an ambient t° of above 40°C, induces hyperactivity in spermatozoa, reducing their survival rate significantly; thus insemination of heat stressed cows carried out several hours before ovulation have a low chance of proving fertile. The survival rate of fertilized ova in a high t° uterine milieu (above 39.7%) has still to be studied.

All these heat stress induced causes, and probably additional non elucidated ones (like other hormonal changes, etc.) lower conception rates appreciably. In those areas where cool nights lower body t°, insemination in the very early morning hours prove successful. During hot seasons wherein conception rates drop below 25%, insemination should be stopped entirely, unless cogent economic reasons dictate otherwise. Cows not cycling 45 days before the onset of the hot, infertile season, should be synchronised and inseminated, to save them from culling.

We now come to the fourth major cause of low production:

Genetic Aptitude

Even a healthy cow, conceiving regularly once a year, correctly fed, managed and milked, kept in an ideally suited climatic environment, cannot produce above her inherited genetic potential.

The quickest and easiest way to achieve high milk yield is the import of high producing pregnant heifers. This has been proved repeatedly by the U.S.A. and Canada in L.A. (mainly Mexico). It is also the most expensive way. One can thus establish high producing private herds, but not replace the dairy herd of an entire country.

To genetically upgrade the milk yielding capacity in the herd of an entire country there are really but 2 alternatives:

1)Upgrade the existing local breed through selection, keeping it pure;

2) Crossing-in desired characteristics by importing bulls or semen.

Using our experience in Israel as an example, as I have been asked to do, I shall try to present it as succinctly as possible.

The first alternative of upgrading the local breed was ruled out because of its low production. We started by importing Damascene dams and bulls, producing 2-2500 kg averages, and from 1925 Dutch-Friesian stock. This died off at a rate of 30% from tick borne blood parasites (20.2% from *Theileria* alone). The offspring of Dutch bulls and Damascene or local cows showed both a higher heat resistance and an early immunity to the endemic tick borne diseases. These characteristics persisted in F2, F3 and later generations. We thus learned very early the advantages of locally born cattle over imported pure bred ones, and started to select locally born bulls as early as possible. The introduction in 1935 of A.I. facilitated genetic planning, according to priorities we had determined about 10 years before. Having little water, no year round pasture—the little there was being highly tick infested, stabulation seemed the only solution. The very high alternative value of water for vegetables, citrus and other fruit dictated our selection for a maximum of milk out of a minimum of cows.

Having no pasture, we breed almost no beef cattle. Meat is therefore expensive, culled dairy cattle being slaughtered at 80-85% of their value as milk cows. This permitted cheap culling and the introduction of rigorous production and fertility standards, and created a short generation interval. We all know that the shorter the generation interval the higher the genetic improvements per year. Needing the meat, we selected for a bigger frame with an aptitude for early maturity and parturition at 23-25 months, shortening the generation interval still further. For the same reasons, we selected for early maturing bull calves, reaching 480-500 kg live weight in 12 months. This had to be achieved in spite of the veterinary-imposed culling of all bulls producing big, distocia-inducing newborns.

As already explained hot climate depresses production and fertility. Profitable culling prices eliminated all low producing infertile cows, thus indirectly selecting for both heat resistance and for high metabolisation capacity of 70% concentrates and above, in a low roughage ration.

Milking parlours, introduced early in the industrial sized dairy herds, and three times a day milking, demand quick milk release and speedy milk flow. All slow cows were eliminated, partly sold to family size farms.

The FAO black and white breed experiment in Poland was mentioned. The idea was to determine the real genetic value achieved by the various national breeds, of some predetermined aptitudes. In order to eliminate all possible influence of the early genetic amelioration, 2 batches of frozen semen from 36-40 preselected young NON-TESTED bulls taken in 1974/5 from each of 9 participating countries (+Poland), 475 doses per bull, (388 bulls in all) 33.699 local black and white Polish nullipara heifers were inseminated, 25.000 conceived. The F_1 generation was then backcrossed, using the same 1974/5 frozen semen, but obviously avoiding consanguinity. The F_2 generation was then tested. As you can see from these results, our genetic aims have been achieved. High milk production, average fat, early weight increase, a big framed cow conducive to early maturity. The bull calves show a relatively light weight at birth, and a rapid and constant weight gain. Rapid milk flow seems to have a high heritability potential. It permits us to gain over 2 milking hours a day in a 300 cow herd and three daily milkings.

To conclude this subject it is interesting to add, that the year of the experiment was extremely unlucky for us. Out of the 38 bulls preselected, 32 showed minus values in their progeny tests and were culled. The 6 others were returned, and another 5 were culled upon second generation results. Only one bull really made it (Tables 6, 7, 8).

Our milk recording averages for the last 50 years are summed up in table 9, (in 1984 our 180 kibuts, industrial sized dairy herds, produced an average of 9056 kg/milk/cow/year). Table 10 shows the 1983 division of herds according to production averages.

The breeding programmes presently applied in most countries have two major drawbacks:

1) Bulls tested to date are evaluated on the performance of their daughters during their first lactations only. In many cases heifers culled are not even included (The U.K. programme includes only heifers producing above 200 days). An important parameter is thus ignored. Many disease manifestations—mainly production and metabolic related—occur during later lactations only. Milk production and reproduction, the two most important factors, can only be evaluated after several lactations.

2) In spite of the fact that culling for production and metabolic reasons occurs only in the female, the male has the far greater impact in selection (but few bulls used). Bulls are reared and kept under totally different conditions, for instance are never exposed to high production stress, forced lipo- and proteinolysis, etc. Being very valuable (A.I. bulls),

TABLE 7. 50 years milk recording in Israel.

Year	Cows	Kg. Milk	% Fat	Kg. Fat
1934	1,029	3,690	3.69	146.1
1944	5,303	4,227	3.55	150.0
1954	14,337	4,197	3.55	149.3
1964	24,013	5,694	3.28	186.8
1974	47,171	6,833	3.22	220.0
1984	66,000	8,734	3.29	287.3

TABLE 8. Average yield per cow five categories, 1983.

Milk Kg	Herds	Ave. Co/he	Ave. M/he	Ave. F/he
>10,000	15	184	10,420	320.5
> 9,000	87	200	9,490	296.3
> 8,000	77	214	8,580	273.1
> 7,000	17	388	7,580	247.5
< 7,000	1	42	6,940	212.0

they are hyper-protected by meticulous, often exaggerated vaccination programmes, effectively hiding any possible disease resistance traits, and fed the best possible rations.

Our breeding programmes in Israel have been adapted to take most of these problems into consideration. Dams are not only selected for 2 standard deviations above herd averages (1st lactation + 2500, 2nd lactation + 4000, 3rd lactation + 5500), and their transmitting value, but also for fertility, ease of calving, absence of metabolic diseases and mastitis. The progeny testing of all sires is carried out three times a year for 3 lactations, computing not only predicted differences for milk and fat production, but also lactation persistency, frequency of mastitis, percent of culling, fertility of daughters, percent of perinatal mortality, percent of distocia in herd mates and in daughters for first and later calving, and metabolic disturbances, apart from conformation and rate of gain and carcass quality of their bull calves.

The Norwegians have recently introduced a scheme by which bulls are evaluated according to diseases in second and third lactating daughters. These results are taken into account when deciding from which bulls to buy their sons. The disease history of the bull's dam is also taken into consideration, as well as their fertility standard (24).

These are definite improvements. Other countries have or will probably shortly follow suit.

All the above show that in order to genetically upgrade a national herd you have today enormous advantages. The frozen semen of all the world's very best bulls is today available on the international market. The specific genetic aptitudes of each bull, his sires, grandsires and dams are recorded and at your disposal. You can choose according to your aims and derive the benefit from the heavy investments others have made in order to select and test their bulls. (In Israel for instance we are *forced* to inseminate 25% of our herd with new young bulls, of which finally but 1 out of 12 passes, showing definite plus values).

All "local cattle" breeds, whatever their race and origin, have been subjected for many generations to acclimatization process. They are well adapted to their environment and have developed a resistance to locally prevalent diseases and adverse conditions.

This is a value asset which must be conserved and perpetuated.

They also possess negative traits we want to change, like, in our case, the lowered genetic potential for milk production.

Once the selection priorities are determined, the choice of breeds possessing the traits desired can be made, out of which the most suitable sires, having a high repeatability record, should be chosen. The frozen semem of the selected sires should then be imported and inseminated into the local females.

The F_1 (50%) daughters should again be inseminated with new generation sires from the same origin, taking advantage of the genetic amelioration achieved there in the meantime, and so on.

There is sufficient circumstantial evidence that those local adaptation and acclimatization traits we want to preserve in the national herd do in effect pass on to the next generations, heredity being strongly reinforced by the fact that the calves are locally born and raised under the same adverse conditions.

Let us consider the recorded performance of the better doble proposito cow. She calves at 34 months, calving in all 4½ times at an, in ideal cases, 15 month interval. She is milked once a day for 200 days, the calf suckling, producing a maximum 3½ kg average or 700 kg per lactation. She lives for 7.2 years (86.5 months) and has a life production of 3.150 kgs/milk during her 52.5 months of production. In all she produces 438 kgs. of milk for every one of her 7.2 years of life.

Her F_3 hybrid offspring (0.125, or ⅞th), calves at 27 months, calving 4½ times with a 13 months calving interval, is milked twice a day for 270 days, producing 11 kgs or 2970 kg/milk per lactation. She lives only 6 years (72.5 months) producing in all 13.365 kgs/milk within 45.5 production months. She needs only 3.4 months instead of 16.7 to produce 1000 kg of milk, producing in all 2.228 kgs for every one of her 6 years of life. (27).

The above is NOT a theoretical exercise but a record of cross breeding results actually obtained in L.A. These performances were achieved on improved pasture with added broiler manure and molasses, with an adequate management system. Cows of this same F_3 stock, fed to the established norms in both energy and proteins, produced above 5000 kg/milk/year averages.

This last fact gives weight to my conviction that the capacity for high milk yields should be bred and later selected for continuously, even if this potential is not immediately taken advantage of.

All of this, Ladies and Gentlemen, can be achieved on one condition, that nationwide A.I. is introduced and maintained. A.I. is a prerequisite for any attempt to introduce a scheme for the genetic upgrading of any national herd.

The main objective is to determine national priorities and select the semen best suited to breed-in these desired genetic aptitudes. Once these are achieved, other traits can be selected for.

For low producing herds, the major priority is for higher production. For hot climate countries, semen of heat adapted high producing sires should be selected, originating from Arizona, California and Israel. For cold regions, Canadian and North-Eastern U.S. bulls should be chosen.

Once the primary aim of an improved genetic milk production capacity is achieved, selection for other hereditary traits should be implemented. Their determination depends upon the specific needs of each country or even region, and these needs should dictate national priorities. The origin of the semen acquired should again be determined by the genetic aptitudes desired, and so on.

Those of us who have achieved high national production averages, as well as those owners who possess high producing herds in L.A. should concentrate their breeding efforts on the following parameters: a higher fertility rate, longevity (at present but 3 lactations), persistency in lactation (lower peaks, long stable production plateau curves), higher protein and fat percentages in milk, adaptation to a higher THI (for sub-tropical regions), speedier return to maximum food intake p.p. (at present 6-10 weeks), better metabolization of food and specific disease and parasite resistance.

Selecting for all these traits will be a long process, some of them having a very low heritability. Therefore research should concentrate on the search for genetic markers. Recognition of gene products does appear to be a prerequisite for controlled genetic engineering (25). As for disease resistance: correlations between histocompatibility antigens and disease susceptibility have been demonstrated in humans and some animals. Similarly strong correlations should be looked for in cattle so that lymphocyte antigens might be used as markers for selecting disease resistant animals (26).

Mr. President, Ladies and Gentlemen,

Low milk production is a multifactorially induced status.

I have tried to define most factors creating and maintaining it, and to present guidelines on how to ameliorate some, and counteract others, in order to increase milk production.

The one message I have tried to pass on to you is that adequate milk production can be obtained in almost every country represented here today by relatively simple and easily applicable means.

If you really want to—you can do it.

To paraphrase the Holy Bible, you can turn your countries into Lands of Milk and Butter.

"Thou shalt be blessed, there shall not be male or female barren among you or among your cattle." Deuteronomy 7:14.

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