Can Britain Feed Itself?

At the moment Britain imports nearly 40 per cent of its food, most of its energy and nearly all of its fibre. In years to come we might have to become more self-sufficient. If so, it would not be for the first time. Many people alive today remember the last time the UK had to resort to home production. Could we do it again? And could we do it with organic agriculture? Simon Fairlie investigates.

In 1975, the Scottish ecologist Kenneth Mellanby wrote a short book called *Can Britain Feed Itself?* His answer was yes, if we eat less meat. The way in which he worked it out was simple, almost a back of the envelope job, but it provides a useful template for making similar calculations. In this article I have adapted and embellished Mellanby's "basic diet" to show how much land modern UK agriculture might require to produce the food we need under six different agricultural regimes — chemical, organic and permacultural, each with or without livestock.

There were two main reasons why I decided to repeat Mellanby's analysis. Firstly, like him, I recognize that in the future the UK may have to become a lot more self reliant than it is now. Secondly, I am interested to see how organic agriculture in particular performs, because the most convincing argument advanced against organic farming by its opponents is that it takes up too much land. This is of most concern in poor, highly populated countries such as Bangladesh, but Britain cannot afford to be complacent: it is more densely populated than China, Pakistan, Vietnam or any African country except Rwanda.

UK LAND USE 1975 AND 2005

	1975	2005
Tillage	4800	4583
Leys	2400	1193
Set aside	-	559
Total arable	**7200**	**6335**
Permanent grass	4800	5711
Rough grazing	6800	6462
Total agricultural land	**18800**	**18509**
Other farm land incl woodland	?	872
Forestry land	2175	2825

K. Mellanby and Office for National Statistics. Early forestry figure is for 1980.

Figure 1.

There are limitations in this kind of statistical exercise; and I do not claim to have carried it out with either the expertise or the thoroughness that it merits. This is, at best, a back of an A4 envelope job. However since I can find no evidence that anyone with the necessary qualifications and stipend to do justice to the subject has been inclined to take it on, I hope that readers will find my offering better than nothing. The results should not be seen as anything other than a rough guide, and a useful framework for thinking about such matters.

Mellanby's Basic Diet

Mellanby took as his starting point the UK's total figure for grain production. In 1975, Britain grew 15 million tonnes of cereals on less than 3.6 million hectares at a yield of about 4 tonnes per hectare. This was the equivalent of 283 kilos per person a year, which is about 2,700 calories a day — comfortable enough for every man, woman, child and elderly person in the country. The total population was 53 million.

Working from this figure of 15 million tonnes of grain, Mellanby built up a somewhat more varied diet, subtracting grain from the total as he introduced other foodstuffs. Table A shows us his "basic rations" of cereal, potatoes, sugar, milk and meat. Every person gets the equivalent of a pint of milk and a pound of potatoes a day, which is what they were actually consuming in 1975: but Mellanby gives them less meat.

The 2,400 hectares assigned for dairy are mainly leys — temporary pastures which are rotated with cropland to provide fertility. Another 2,400 hectares of permanent grazing are for raising beef. As for sheep, Mellanby retains the 28 million of them that there were in 1975, without bothering to work out how much land they take up or how much meat or calories they provide — in fact they do not contribute much more than one per cent of the total diet.

The three items most obviously missing from Mellanby's basic diet are beer, fat and vegetables. Beer, since it is made of barley and has a calorific value of 100 to 150 calories a pint,

MELLANBY'S BASIC DIET 1975

Population 53 million. Agricultural land 18.8 million hectares.

• 5.3 million hectares arable

• 5.7 million hectares of pasture

• 7.8 million spare hectares

TABLE A

	Consumption gms/person/day	Calories in diet kcal/person/day	UK production million tons/year	Yield tons/ha	Arable land 1000 ha	Perm: pasture 1000 ha	Rough pasture 1000ha
Cereals for human food	530	1850	10.25	4.166	2460		
Potatoes	453	300	8.76	32	275		
Sugar	32	100	0.625	5	125		
Milk	568	330	11	4.58	2400		
Beef (grass reared)	56	150	1.08	0.45		2400	
Sheep	14	37	276	0.084			3290
Total calories per day		2767					
Land available (excl woodland)					7200	4800	6800
Spare land					1940	2400	3510
Total land use					**5260**	**2400**	**3290**

• One hectare of arable plus one of pasture feeds 10 people is included within the grain figure. Fat is a more serious omission, involving substantial amounts of land and Mellanby could usefully have included it in his calculations. He may have been deterred by the fact that edible rape oil had barely been invented in 1975, so his self-sufficient Britain would have been dependent for its fat supply on lard. As for vegetables and fruit, Mellanby is content simply to point out that these can be provided in allotments and gardens.

These omission don't undermine his main point, since there are millions of hectares left over, which could be put over to pigs, more cows for butter, vegetables, poultry or whatever anybody felt like. There is, in fact, no shortage of land whatsoever.

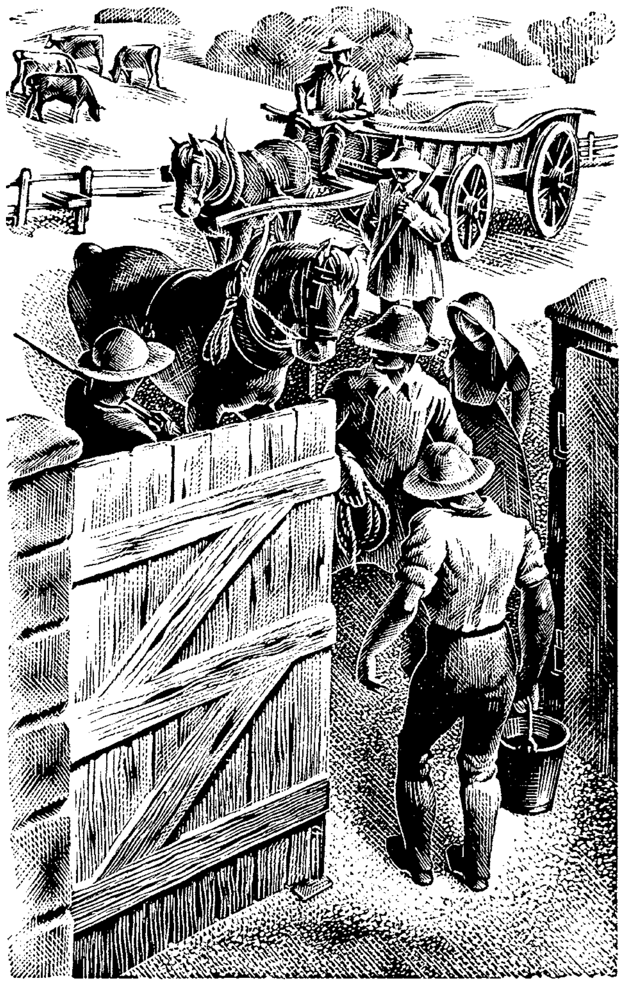
Mellanby's calculations are for so-called "conventional" agriculture using nitrogen fertilizers and other chemicals, which makes his task much easier; but he does mention the potential of organic agriculture and concludes that, although less productive than conventional agriculture, it could still probably feed the country using an extra 33 per cent of the land.

The Mellanby Diet Today

Since 1975 a number of factors have changed: the population has risen from 53 million people to 60.6 million, but crop yields have risen much faster. In 2004 Britain grew nearly 22 million tonnes of grains on 3.1 million hectares at a yield averaging over 7 tonnes per acre.

Figure 1 shows how, as a result, land use has changed in the last 30 years. The total agricultural area has declined only slightly, but there has been a large shift away from temporary grass ley, reflecting the decline of the dairy herd, as well as a smaller drop in arable land and the arrival of set-aside. The amount of land under permanent pasture and forestry has increased correspondingly.

Table B is Mellanby's 1975 table updated to 2005, to take account of the rise in population and increases in crop yield. The same diet for 14 per cent more people can now be provided on 86 per cent of the 1975 arable land area. However beef production nowadays is less efficient than in the 1975 model. There is a reason for this, which I shall explain later on.



Agnes Miller Parker

I have made one addition to Mellanby's table: some extra hectares to account for vegetables and fruit, which require more land than corn does to produce a given number of calories. About 160,000 hectares are devoted to horticulture in the UK at the moment, but we import about 60 per cent of all our fruit and veg, so we consume over 400,000 hectares worth. This is a substantial amount of land; but I can understand why Mellanby left it out, because calculating the area involved and the number of calories for such a variety of different crops is tricky.

CHEMICAL WITH LIVESTOCK 2005

Population 60.6 million. Agricultural land 18.50 million hectare. Forestry etc 3.69 million hectares

- **4.4 million hectares arable**
- **6.4 million hectares of pasture**
- **7.6 million spare hectares**

TABLE B

	Consumption gms/person/day	Calories in diet kcal/person/day	UK production million tons/year	Yield tons/ha	Arable land 1000 ha	Perm: pasture 1000 ha	Rough pasture 1000ha
Cereals for human food	500	1700	11.06	7.3	1515		
Potatoes	453	300	10	44	227		
Sugar	32	100	0.707	9	78		
Vegetables and fruit	500	150			400		
Milk (inc butter cheese etc)	568	330	12.5	7.0/cow	1252		
Beef	56	150	1.24	0.43		2758	
Cereals for animal feed			6.69	7.1	917		
Sheep	14	37	0.31	0.084			3690
Land Available [Total Calories]		[2767]			6335	5711	6462
Spare land					1946	2953	2772
LAND USED					**4389**	**2758**	**3690**

- **One hectare of arable plus 1.5 hectare of pasture feeds 14 people**

CHEMICAL VEGAN 2005

Population 60.6 million. Agricultural land 18.50 million hectare. Forestry etc 3.69 million hectares

• 3 million hectares arable

• 15.6 million spare hectares

TABLE C

	Consumption	Calories in diet	UK production	Yield	Arable land	Perm: pasture	Rough pasture
	gms/person/day	kcal/person/day	million tons/year	tons/ha	1000 ha	1000 ha	1000ha
Cereals for human food	500	1700	11.06	7.3	1515		
Potatoes	453	300	10	44	227		
Sugar	32	100	0.707	9	78		
Rape Oil	35	310	0.774	1.2	645		
Dried Peas	80	207	1.77	3.75	471		
Vegetables	500	150			400		
Land Available [Total Calories]		[2767]			6335	5711	6462
Spare Land					3336	5711	6462
LAND USED					**2999**	**0**	**0**

• **One hectare of arable feeds 20 people**

Mellanby Goes Vegan

Mellanby could feed his population quite comfortably by reducing the amount of meat, so what would happen if it went vegan? In order to make a comparison with stockless agriculture providing a non-animal diet, in Table C I have substituted the meat and milk in Mellanby's ration with an equivalent ration of protein (peas) and fat (rape oil). The meat-eaters get their fat from milk (about 24 grams per day) and meat, but both diets are stingy on fat for anyone wanting to lead a physically active or an indulgent lifestyle.

Table C shows that chemical stockless agriculture is by far the most economical in terms of land use and can grow the entire ration on less arable land than that required by chemical livestock agriculture to provide its non-meat component. This is the ideal farming system for any society wishing to reduce the number of its farmers to a minimum, or to grow wide areas of biofuels, or to support large urban populations — all main objectives of modern social policy. With industrial processing of pea, bean and grain protein into artificial meat and milk, a semblance of an animal-based diet could be provided for about 200 million people.

Vegan Organic: Reliance on Green Manure

In Tables D and E I have again updated Mellanby's diet to 2005, but this time for organic husbandry. Both these organic diets, vegan and livestock, take more land than their chemical counterparts. This is partly because average grain yields obtained by organic agriculture today in Britain are less than 60 per cent of those obtained by chemical farmers; in fact organic wheat yields today are similar to those of chemical agriculture in 1975.

But lower yields are only half the problem. To obtain yields above a bare minimum of around 750 kg of grain per hectare, land has to be fed with extra nitrogen. Organic systems by definition do not use synthetic fertilizer, so nitrogen is either imported from other land where it is not required, usually in the form of animal manure; or obtained by inserting into the rotation a crop of leguminous plants such as beans, clover or lucerne, which extract nitrogen from the atmosphere. A dedicated crop of legumes, which is not fed to humans or animals, but ploughed in to provide fertility, is called a green manure. Green manures which occupy the ground for a whole season lower the yield from each hectare still further.

In Table D I have assumed that one hectare out of every three arable hectares is used for green manure — except for the pea crop which fixes its own nitrogen from the atmosphere. This adds an extra 2.2 million hectares to the vegan organic land-take, with the result that it requires more 14 per cent more arable land than is in use today (including set-aside). This is not a problem, since it can be taken from the pasture, for which the vegan diet has no use.

I have used the 33 per cent green manure ratio because that is the figure given in my main source, the *Organic Farm Management Handbook*. However there are a number of experiments in the UK and elsewhere in which green manure constitutes only 20 or 25 per cent of a stockless rotation. Several of these have

ORGANIC VEGAN 2005

Population 60.6 million. Agricultural land 18.50 million hectare. Forestry etc 3.69 million hectares

• 7.3 million hectares arable

• 11.2 million spare hectares

TABLE D

	Consumption	Calories in diet	UK production	Yield	Arable land	Perm: pasture	Rough pasture
	gms/person/day	kcal/person/day	million tons/year	tons/ha	1000 ha	1000 ha	1000ha
Cereals for human food	500	1700	11.06	4.3	2572		
Potatoes	453	300	10	25	400		
Sugar	32	100	0.707	7.5	94		
Rape Oil	35	310	0.774	0.8	968		
Dried Peas	80	207	1.77	3	590		
Vegetables	500	150			450		
Green manure					2242		
Land Available [Total Calories]		[2767]			6335	5711	6462
Spare Land					-981	4730	6462
LAND USED					**7316**		

• **One hectare of arable feeds 8 people**

ORGANIC WITH LIVESTOCK (2005)

• **8.1 million hectares arable**

• **7.8 million hectares of pasture**

• **2.6 million spare hectares**

TABLE E

Population 60.6 million. Agricultural land 18.50 million hectare. Forestry etc 3.69 million hectares

	Consumption gms/person/day	Calories in diet kcal/person/day	UK production million tons/year	Yield tons/ha	Arable land 1000 ha	Perm: pasture 1000 ha	Rough pasture 1000ha
Cereals for human food	500	1700	11.06	4.3	2572		
Potatoes	453	300	10	25	400		
Sugar	32	100	0.707	7.5	94		
Vegetables and fruit	500	150			450		
Green manure					1696		
Milk (inc butter cheese etc)	568	330	12.5	per cow 5.8	1898		
Beef	56	150	1.24	0.29		4100	
Cereal for dairy cows			2.936	4	657		
Cereals for beef cows			1.656	4	328		
Sheep	14	37	0.31	0.084			3690
Land Available [Total Calories]		[2767]			6335	5711	6462
Spare Land					-1760	-149	2623
LAND USED					**8095**	**4100**	**3690**

• **One hectare of arable plus one of pasture feeds 7.5 people**

maintained respectable yields for 10 or 15 years, though some require additions of phosphorus. More astonishingly, the Rodale Institute in Pennsylvania[1] has grown cash crops continuously for 20 years on the same land, fertilized only by winter cover crops and soya beans. I am unclear why this has not been matched in the UK, but clearly it requires good land and there are also sites in the USA which have failed to repeat Rodale's performance. If these experiments could be replicated on a widespread scale, then the requirement for arable land for green manure would be considerably reduced in stockless systems.

Organic Livestock: the High Yield Paradox

In organic mixed farming systems, nitrogen is provided by manure, and by leys — temporary pasture including clover or other nitrogen fixing plants which after say four or five years is ploughed up for two years or three cropping, and then put back to ley. Essentially these are green manures in which part of the nutrients pass through grazing animals before finding their way back to the cropland — though a proportion are creamed off to provide milk, meat, leather etc.

In Table E, 3 hectares of ley is assumed to fertilize 2 hectares of cash crops. At this rate the 1.9 million hectares of ley for dairy pasture, plus a small amount of manure from the beef, does not provide enough fertility for all the crops grown and so the organic livestock model also has to rely on 1.7 million hectares of green manure. If there were pigs or chickens, they would provide more manure — but not enough to grow the corn necessary to feed them.

The organic livestock model is worrying because it is very expensive on land. It would require the ploughing up of 1.76 million hectares of our existing pasture land to provide cropland and leys. This in turn means that there is not quite enough permanent pasture left for the beef — there is a shortage of 149,000 hectares, which has to be taken out of the rough grazing. Only 2.623 million hectares are left for other uses such as wildlife parks or biomass production.

There are two main reasons for the heavy land requirement of organic farming. The first is that average yields of organic wheat and potatoes are only 60 per cent of those achieved with the use of chemicals. With most other crops the difference between organic and chemical is less pronounced, but wheat and potatoes are the staples. According to Elm Farm researcher Martin Wolfe, the main problem is that modern wheat varieties have been highly bred specifically for non-organic production: they are "short-strawed with an open canopy, so that they compete less well with weeds, and there is a similar contrast in disease resistance . . . There is an urgent need, therefore, to breed organic wheat."[2]

The other problem is the cows, particularly the beef cows which take up an enormous amount of land for very little return. There appears to be too much beef, which is strange because it is the same amount per person as in Mellanby's 1975 scenario, and it didn't cause any problem then. Admittedly there are now 7 million more mouths to feed, and also Mellanby puts fertilizer on his leys. But even so the beef sector seems to have expanded disproportionately. In 1975 the beef herd occupied the same amount of land as the dairy herd ; but now the area devoted to beef (including grain for cattle feed) is almost twice as large.

Here, paradoxically, it is high yields that are causing the problem. The figures in Table E are derived from Elm Farm's *Organic Farm Management Handbook* 2007, and they reflect a more modern management approach in an era of cheap subsidised corn. Whereas Mellanby's cows yielded just 3,600 litres of milk a year, organic cows today average 5,800 litres, only 1200 litres less than non-organic cows. The trouble is that to achieve this they need fairly large amounts of grain — over a tonne a year each — whereas Mellanby's cows are grass-fed.

The need for grain is not the only problem caused by the high milk yield of these cows. The size of Mellanby's beef herd was dictated by the number of calves that his low yielding cows produced. But now, because there are fewer cows producing the same amount of milk there are fewer calves; this means that in order to produce the same amount of beef as in Mellanby's diet, we have to run a dedicated beef suckler herd — nearly two million cows which produce nothing except one beef calf a year, whereas Mellanby's calves were all the by-product of cows supplying milk. This cancels out much of the advantage of high-yielding cows and is the main reason why land occupied by beef has swelled from 2,400 hectares in 1975 to 4,100 in Table E.

LIVESTOCK PERMACULTURE 2005

Including pigs, poultry, textiles, tractor or horse power and timber

- **7.5 million hectares arable**
- **5.9 million hectares of pasture**
- **6 million hectares of woodland**
- **2.8 million spare hectares**

TABLE F

Population 60.6 million. Total agriculture and forestry land 22.205 million ha.

	Consumption gms/person/day	Calories in diet kcal/person/day	UK production million tons/year	Yield tons/ha	Arable land 1000 ha	Perm: pasture 1000 ha	Other kand 1000ha
Cereals for human food	448	1526	9.9	4.3	2302		
Potatoes	453	300	10	25	400		
Sugar	32	100	0.707	7.5	94		
Vegetables and fruit	500	150			100	50 (100)	
Hemp and flax	5 kg/year		0.303	3	100		
Horse or biofuel					463		
Green Manure					430		
Milk (incl butter, cheese)	568	330	12.5	3.7 (3.26 net)	2825	1765	
Beef (grass reared)	33	86	0.735	0.4		1740	
Cereals for pigs	bacon 36	180	1.2	4.3	279		
Cereals for hens/eggs	(egg/chicken)30	50	2	4.3	465		
Sheep	9	24	0.2	0.084			2372
Leather and sheepskin	1.46 kg/year						
Wool	750 kg/ year						
Fish	11	11	0.243				
Timber, firewood				3			6000
Wild meat	5	10	0.11	0.031			2821
LAND USED [total calories]		[2767]			**7458**	**3555**	**8372**

- **One hectare of arable plus 0.8 ha of pasture supplies 8 people**

I therefore decided to see what would happen if I reduced the beef herd to a size commensurate with the dairy herd and moved back to Mellanby's system of running a larger number of low yielding dairy cows which can subsist entirely on grass. This is akin to what has been happening in New Zealand since they abolished farm subsidies, because it is more competitive — which is why New Zealand butter is advertised as coming from free range cows. And it is what I have done in Table F. If you examine just the cattle figures in it, you will see that the milk yield has been reduced from 5800 to 3700 litres a cow, and the total amount of beef produced has bee reduced from 1.24 million tonnes to 735,000 tonnes; but the number of dairy cows is increased so that the total amount of milk produced, 12.5 million tonnes, remains the same as in Table E.

In terms of land-take the lower yielding cows produce food almost as efficiently as the high yielding cows. The ratio of hectares of land to calories of beef and milk from the corn-fed cows in Table E is 6983 :480 or 14.5:1 whereas from the grass-fed cows in Table F it is 6330:416 — or 15.2:1. In other words, a 63 per cent increase in milk yield results in a mere five per cent increase in land productivity.

But there is another big difference between the two. The grass-fed cattle in Table F provide over 2.8 million hectares of ley that can be used in rotation to help fertilize over a million hectares of crops — whereas in Table E the 1.9 million hectares of ley that the corn fed cattle bring with them isn't enough to fertilize the million hectares of grain they eat. The low yielding cows are nitrogen providers whereas the high yielding cows are nitrogen takers.

There is one other matter of interest. Since 2004 the net organic yield for wheat has risen from 3.8 tonnes a hectare to 4.3 tonnes; but the milk yield for organic cows has actually dropped, from 6000 litres to 5,800 litres, and so has the amount of corn they are fed. Both these trends are in a benign direction

A Permaculture Approach

My main purpose in Tables F and G is to go another step further and see whether the UK could become more self reliant, not only in food, fodder and fertility, but also in fibre and fuel? Our environmental footprint currently stretches across untold ghost acres around the world; if suddenly we had to shoehorn it into the 22 million hectares of non-urban land we have in this country, how would we cope? Could this be done organically, whilst keeping a reasonable amount of meat in our diet for those who wanted it, and ensuring that a reasonable proportion of the country is reserved for wildlife?

Table's F and G reflect a more permacultural approach, by which I mean permaculture on the macro-scale, involving increased integration of lifestyle with natural and renewable cycles, rather than mulching, intercropping and herb spirals. Some of the measures taken require a change in our land management systems, and also in human settlement patterns. This is a society in a state of energy descent, with increasing dependence upon renewable resources and (consequently) a localized economy, more integrated with natural processes.

Here is a list of the main features which I have introduced. There is particular attention to livestock because they are the most extravagant in terms of land use. Get the livestock balance right and other things fall into place.

Meat and Dairy The amount of beef in the diet has been reduced both by no longer running a suckler herd, and by reducing the average age at which beef cows are slaughtered. There are 83 grams of red meat a person a day. For a family of four, this is the equivalent of a 5lb Sunday joint, which could probably be spun out till Tuesday or Wednesday. Together with a smidgeon of chicken and fish it comes to 38 kilos of meat per year, which is about half the amount people eat now. The volume of milk consumed is the same as now, and everyone also has a couple of eggs a week. Farm animals provide 670 calories of the daily ration of 2767, whereas in Mellanby's basic diet they only provided 517.

Pigs To compensate for the reduced amount of beef in the diet, I have introduced pigs. Although partially fed on grain, these are efficient because their diet consists of two thirds crop residues and food waste. This ought to be possible since in the early 1990s even commercial pig feed consisted of 50 per cent food waste[3], and on top of that there is all the domestic food waste which currently goes into landfill. The figure of 2,767 calories per person (including children and old people) allows for around 700 calories of food waste[4], which in theory is enough to provide our pigs with all their food. (The draconian laws forbidding the feeding of even sterilized catering and domestic waste to pigs, introduced in a panic after the 2001 foot and mouth epidemic, need to be repealed). I have kept this margin tight because selling feed to small-scale pig units on mixed farms is an economical way of ensuring that the nutrients in food processing waste cascade back to the land. The pigs also bring fat into the diet, and produce it on less land than rape oil.[5]

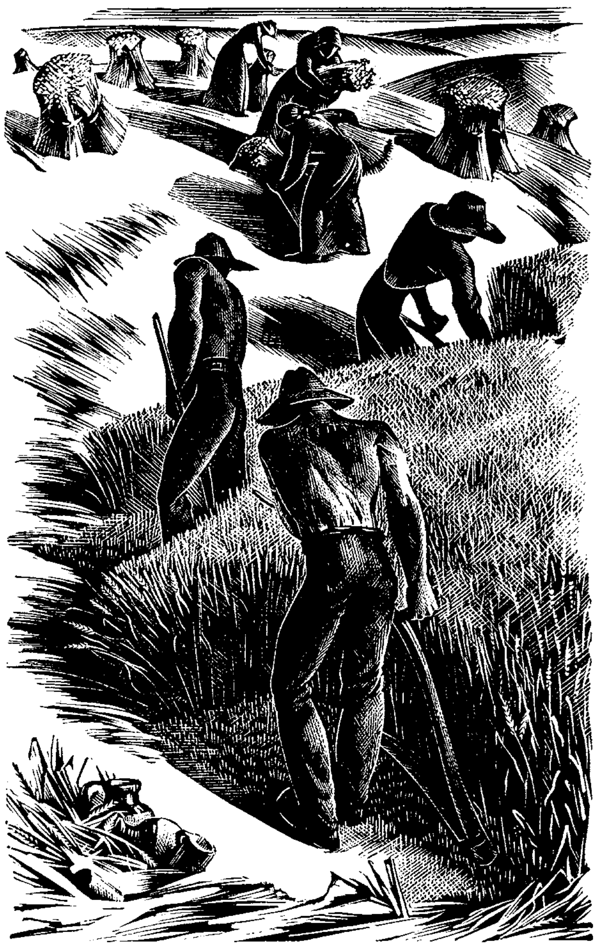
Chickens I have also introduced chickens, which in this model are fed on grain. They take up more land for less calories than pigs, but this is only because the pigs are getting all the food waste. It is possible to feed much of the waste to hens, and they convert it into protein more efficiently than pigs. But the advantage of pigs in a northern country is that they produce fat, when little else does. If resources became scarce, I would expect commercial chickens to be among the first to rise in price, (a boiling fowl was a luxury to be had only on special occasions in the 1950s) but there would still be plenty of opportunity for backyard hens fed on household scraps.

Fish I have allowed the carnivores a small amount of fish, equivalent to about half of current consumption levels. If European countries reverted to local control of fishing grounds, then management of UK stocks would improve and catches eventually rise. There are some wonderful permacultural systems in Vietnam and China where fish farming is part of the cycle, but I don't know enough about their potential in the UK to include them here.

Sheep I have reduced the number of sheep from 27 million in Mellanby's scenario to 18 million, because they don't produce much food and there is a widespread perception that they have too much of a monopoly of our uplands at the moment. But we might think twice about this because, in the absence of plastic fleeces shipped in from China, we may need more wool than 18 million sheep can produce. Sheep would be bred for heavier fleeces.

Wild Meat I could find no figures for the volume of meat available from wild herbivores, but it is probably minimal. The figure given is roughly the same as the estimated quantity of wild rabbit meat eaten in 1953.

Fruit and Veg In the localized economy envisaged here, a large proportion of fruit and vegetables could be grown more intensively on allotments, in gardens and on urban land. Much top fruit would be grown not on arable land, which needs weeding, but in orchards which could be grazed, or in the vegan case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mown. I have reduced the area of arable put down to horticulture in Table F to 100,000 hectares.

Wheat High yields come through breeding for seed production at the expense of stem production. The lower wheat yields associated with organic production can be partially offset by producing thatching straw — another form of biomass that will be in demand if we enter a path of energy descent.

Textiles I have been unable to establish what current UK consumption rates of textiles are, and since so much of it is frivolous there is not much point. Textile fibres do not take up an enormous amount of land. Except for fashion models, most of us eat more than we wear. In Table F I have allocated 7.25 kilos per person per year (a domestic washing-machine load), provided by hemp and flax, wool and leather.

Nutrient cycles Additional nitrogen for crops comes from three main sources. Enough nitrogen to fertilize 1 million hectares of crops can be obtained from recycling human sewage, preferably on crops for animal rather than human consumption. This requires a society which does not pollute its human waste with heavy metals, through contamination with liquid run-off and effluent. Just over a million hectares can be supplied with nutrients through ley farming. And a further 750,000 hectares could be fertilized with a proportion of the available animal manure. How much can be recuperated depends upon how livestock are managed. In the case of sheep, this might involve bringing them in at night, to shit in the farmyard, as is normal practice in many places on the continent. Any shortfall would have to be met by green manure, at a rate of one hectare for every two cultivated.

VEGAN PERMACULTURE

Including extra veg, textiles, tractor power and timber

- 7.2 million hectares arable
- 6 million hectares of woodland
- 8.8 million spare hectares

TABLE G

Population 60.6 million. Total agriculture and forestry land 22.205 million ha.

	Consumption	Calories in diet	UK production	Yield	Arable land	Orchard	Other land
	gms/person/day	kcal/person/day	million tons/year	tons/ha	1000 ha	1000 ha	1000ha
Cereals for human food	491	1670	10.9	4.3	2534		
Potatoes	453	300	10	25	400		
Sugar	32	100	0.707	5	94		
Rape oil	35	310	0.774	0.8	968		
Dried peas	80	207	1.77	3	590		
Hemp and flax	7 kg per year		423	3	146		
Vegetables, fruit, nuts	666	180			150	150	
Biofuel					725		
Green manure					1646		
Timber, firewood			18	3			6000
Wildlife, spare land							8803
LAND USED [total calories]		[2767]			7253	150	6000

- **One hectare of arable supplies 8.5 people**

In the absence of supplies of imported rock phosphate, phosphorus rather than nitrogen might become the main constraint upon crop yields, in which case we would have to ensure rigorous recycling of animal manures, human sewage, slaughterhouse wastes etc — a further reason for dispersing population around the countryside. A vegan system in particular might have problems maintaining phosphorus levels.

Biomass I have not allowed for much intensive biomass energy production, mainly because it takes up arable land that could be better used for food. In non-arable areas, I prefer natural woodland to short rotation coppice, because of its amenity and wildlife value; the prospect of vast acreages of the countryside curtained in eight foot high willow coppice monoculture is not very appealing. However, there is a good case for arable biomass production on farms to provide fuel for tractors. I have allocated 10 per cent of the arable land either for biomass to run machinery, or else to grow feed for draught animals.

The Livestock Permaculture land economy outlined in Table F produces all its food, a substantial proportion of its textiles, and the energy for cultivating its fields on 13.4 million hectares, a little over half the entire country. The more orthodox organic system in Table E requires nearly 16 million hectares, it doesn't produce any fuel, it is low on fat, and it produces less meat: only 187 calories in the daily ration, compared with 272 in the permaculture model. The improvement comes through using animals for what they are best at, recycling nutrients and waste — and avoiding feeding them grains.

Woodland or Wildland

We are left in Table F with about 9 million hectares, of which 3.7 million hectares are currently classed as woodland or else "other land on agricultural holdings including woodland", and the rest are rough grazing — including 1.5 million hectares of grouse moor. There are therefore nearly five million hectares of mostly poor quality land spare, for which the most obvious uses are either to "rewild" it, or else to put it over to woodland.

In the livestock permaculture scenario I have opted to leave slightly over half of this area for wildlife and to convert the other half to woodland. This gives us about six million hectares of woodland, around a quarter of the entire country. This is still a lower proportion than in France (27 per cent), the EU (40 per cent) or the world (29 per cent). Six million hectares of biodiverse woodland, coppice and plantation could produce 36 million cubic metres of timber and pulp — three quarters of what we currently consume (most of which is imported). A saner society, without all the junk mail, newspaper supplements no one reads, tacky throwaway furniture and so on could make do with a lot less.

On the other hand six million hectares of woodland, could also produce enough firewood to heat six million well insulated family homes (at three tonnes per hectare and per home). This is not incompatible with timber production. All pulp and timber, when it comes to the end of its economic life, is firewood.

This leaves three million hectares for wildlife, an eighth of the country, not as much as some people would wish to see. This land, since it is specifically not woodland, would have to be grazed by edible, semi-wild herbivores such as deer, primitive types of ox, or Konik ponies.

The wild area could be increased by reducing the sheep flock still further, at the expense of a small amount of meat and some rather valuable wool; by producing more "pink veal" (from young grass-fed cattle) and less mature beef; or by reducing the number of dairy cows and the amount of milk consumed. In each case, to compensate, a smaller area of land would have to be converted to crop production and green manure.

Vegan Permaculture

Table G outlines, as far as I am able, a vegan permacultural vision, based on the same data. I have introduced more flax and hemp to make up for the lack of wool and leather; and since the meat-eaters have been allowed pork and eggs, I have increased the variety in the vegan diet by allocating an additional 100,000 hectares for fruit and vegetables, most of which is grown on non-agricultural or orchard land, and fertilized with municipal compost. Perhaps I should allow them more. Nuts are an obvious choice, but reliable information about yields is difficult to find. The vegan system uses human sewage for fertilizer like the livestock system, though there would be more of a problem avoiding applying it to human edible crops.

The obvious, and some would say overwhelming advantage of the vegan system is that it uses less land. However, it is the grazing land that the vegans economize on. They require almost as much arable land as the meat-eaters, mainly because of the lack of manure, and the expense of providing fat or oil. In fact the area of land under annual cultivation in the vegan system in any one year (7.2 million hectares) is considerably greater than in the livestock system where more than a third of the arable land consists of grass leys, and only 4.6 million hectares hold annual crops.

The vegans could perhaps reduce the area of green manure by more efficient use of cover crops, or by importing hay or leaf mould for mulch. There are also the residues from rapeseed oil, biofuel, and products such oat milk and pea milk which could be used as fertilizer — though vegans might be tempted to trade these with pig keepers.

The disadvantage of the vegan model, from the peasant perspective, is that it results in a lop-sided land economy, with almost all the activity concentrated in the arable area; and overall it appears to provide less employment on the land than the livestock system. The less arable areas of Britain would become agriculturally redundant. All that empty space in the grassland area gives the relatively small growing area a rather compacted urban feel, and I worry that the spare land might get filled up with monoculture energy crops.

But that depends upon what the vegans decide to do with it, and that is not really for me to say. I have so far failed to find any vegan land-use vision that maps out in detail what might be done with the large areas of UK land that would be liberated or abandoned, depending on your viewpoint, if we all turned vegan.[6] So, vegan permaculturists, we know you are out there, here is your chance. Fill in the blank area on Table G — all 9 million hectares of it — with whatever land uses you think are most appropriate, and we'll publish your "Vegan Vision for Rural Britain" in a future issue of *The Land.*

That is not to say that the people's choice has to be either one thing or the other, . Vegan and livestock land use systems can coexist well enough side by side, as long as boundaries are drawn and fences maintained. Instead of being strictly vegan or enthusiastically carnivore, it is entirely possible to have a level of compromise between the two approaches outlined in Tables F and G, and indeed that is more likely.

Conclusion

The main conclusion to be drawn from this exercise is that organic livestock-based agriculture, practised by orthodox methods and without supplementary measures, has the most difficulty sustaining the full UK population on the land available, while other management systems can do so with a more or less comfortable margin.

However organic livestock agriculture becomes more efficient and sustainable when it is carried out in conjunction with other traditional and permacultural management practices which are integral to a natural fertility cycle. These include: feeding livestock upon food wastes and residues; returning human

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sewage to productive land; dispersal of animals on mixed farms and smallholdings, rather than concentration in large farms; local slaughter and food distribution; managing animals to ensure optimum recuperation of manure; and selecting and managing livestock, especially dairy cows, to be nitrogen providers rather than nitrogen stealers.

These measures demand more human labour, and more even dispersal of both livestock and humans around the country than chemical or vegan options. Effective pursuit of livestock-based organic agriculture of this kind requires a localized economy, and some degree of agrarian resettlement. Other management systems based on synthetic fertilizers or vegan principles lend themselves more easily to the levels of urbanization currently favoured by the dominant (and mostly urban) policy makers.

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1. D. Pimentel et al, *Organic and Conventional Farming Systems: Environmental and Economic Issues*, Cornell University, 2005; http://ecommons.library.cornell.edu/bitstream/1813/2101/1/pimentel_report_05-1.pdf

2.Martin Wolfe, *Recognizing and Realizing the Potential of Organic Agriculture*, presentation at Global Ag 2020 conference, John Innes Centre, April 19, 2001, www.biotech-info.net/organic_potential.html

3. Peter Brooks, *Rediscovering the Environmentally-Friendly Pig*, Seale Hayne, 1993, unpublished.

4. US citizens have 3,600 calories of available food, but only eat 2000 calories per capita. USDA figures, cited in V. Smil, *Enriching the Earth*, MIT, 2004, p 166.

5. Pigs produce fat on less land than rape in our scenario because they are fed substantial amounts of waste. If you gave them no waste and grew all the pig food organically and fed it at a feed/meat conversion ratio of 5:1 you would get about 800 kilos of fat and meat per hectare, which is the same as our estimated yield of organic rape oil. Soya bean oil yields are much lower — an average non-organic harvest is about 2.4 tonnes per ha of beans yielding about 450 kg oil. (FAO, *Livestock's Long Shadow,* 2006, pp. 43-44).

6. The ideas expressed in Mark Fishers' website www.self-willed-land.org.uk are highly compatible with a vegan land economy.

For further sources see the foot of p.26 .

Can Organic Agriculture Feed the World?

The good news for supporters of organic agriculture is that Britain can feed its industrially bloated population through organic agriculture (albeit with a reduction in meat consumption). The bad news is that it takes a lot of land compared to chemical farming, not only because yields are lower, but also because more land is required to capture nitrogen either through green manure, or through livestock.

Opponents of organic agriculture have not been slow to point this out. There is a camp of 800 scientists and pundits, including Norman Borlaug (architect of the green revolution), James Lovelock (of Gaia fame), Dennis Avery (of the Hudson Institute) and Matt Ridley (ex-chairman of Northern Rock) who, under the aegis of the Centre for Global Food Issues, have signed a declaration "In Support of Protecting Nature with High Yielding Farming and Forestry".[1] They are shrill, partisan, and the darlings of agribusiness: no less than 21 representatives of Monsanto and seven of Syngenta signed their declaration. I call them the GOOFs (Global Opponents of Organic Farming)

The gist of their declaration is that to feed the future population of 8.5 billion people which industrialization will spawn, we will have to resort not only to industrial fertilizers, but also to genetic manipulation. Any attempt to secure nitrogen, phophates and other nutrients through natural organic means would require undue encroachment upon natural habitats — if not their total destruction. GOOFs share James Lovelock's vision (see p. 13 of The Land 3) of a future where a third of the land is given over to wilderness, and a third to agribusiness, while the majority of the population is crammed into the remaining third and fed on junk food.

Their case is put forward more powerfully in a book on the history of nitrogen fertilizer by north American academic Vaclav Smil, entitled *Enriching the Earth*.[2] Smil is not banging such a loud ideological drum as the GOOFs, and he does not shrink from cataloguing the problems that chemical agriculture has caused.

Smil's argument is expressed in a graph in his book, showing that in the early 1960s China fed a population of about 660 million, with negligible consumption of artificial fertilizer — almost all its nitrogen was derived from organic sources. By 1996 the population was close to 1.2 billion, applications of synthetic nitrogen had increased more than 50 fold, and 75 per cent of all nitrogen applied to crops was synthetic. In the same period average per capita food consumption increased from about 2000 calories, to 2,700; and meat consumption increased from a reported figure of 1.4 kg per year in 1961, to over 50 kg today, on more or less the same area of land.This achievement, Smil argues, could not have been achieved using traditional organic techniques which in the 1950s were already stretched to their limits — and one has the nasty feeling that he might be right.

There are plenty of organic activists and farmers around the world trying to prove that the GOOFs are wrong. Farmers are experimenting with organic intensive rice systems (SRI) and nitrogen fixing organisms such as azolla, a waterweed which can be integrated into rice/fish farming systems. A recent report by Catherine Badgley of the University of Michigan and others, published in 2007, puts forward the organic case, relying partly on the Rodale experiments.[3]

But the UK organic movement seems worryingly unconcerned about these matters — perhaps because British organic farmers are currently basking in a sea of excess fertility, the residue of 100 years of chemical fertilizer application and 200 years of importing biomass from the colonies.

The Land sent a pre-publication copy of *Can Britain Feed Itself?* to the Soil Association for comment. They said they would respond, sat on it for over two months, and, despite repeated reminders, declined to comment. They did send us a copy of their five page *Briefing on Organic Yields*, which makes barely any mention of sustainable nutrient cycles or of extra land required to fix fertility. The briefing states that European organic yields are 60 to 80 per cent of conventional yields. *The Land*'s assessment suggests that chemical livestock agriculture uses 54 per cent of the amount of arable land required by organic agriculture.

The arguments of Smil and the GOOFs require a more considered response than this. They may or may not be right that there are too many people in the world to feed through organic agriculture. If they are right, that doesn't negate the intrinsic virtues and advantages of organic farming, but it puts organic farming in a similar bracket to orang-utans, nomadic tribes and other phenomena that can't compete in a world with so many humans.

If, in the face of population pressure, the organic movement is to champion sustainable agricultural systems which keep peasants on the land and consumers in touch with the seasons, it may have to adopt different priorities: for example a sequential test which permits chemical fertilizers to be used only when organic nutrients are in short supply. Blind adherence to doctrines and standards which cannot feed people will brand organic goods as a niche product for the privileged in a world dominated by agribusiness.

S.F.

1. www.highyieldconservation.org/declaration.html
2. V Smil, *Enriching the Earth*, MIT, 2001.
3 C Badgley, et al, "Organic Agriculture and the Global Food Supply", *Renewable Agriculture and Food Supplies*, 22 pp. 80-86, July 2007.

SOURCES FOR *CAN BRITAIN FEED ITSELF?*

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Figures for 2005 are derived, whenever possible, from:

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N Lampkin, M. Measures and S Padel, *Organic Farm Management Handbook*, Organic Farming Research Unit, University of Wales Aberystwyth and Elm Farm Research Centre, 2007.

Annual Abstract of Statistics, Office for National Statistics, Chapter 21, 2006.

Agriculture in the UK, Chapter 5, DEFRA, 2005.

Where crop yield figures are not available in these publications I have deduced them from information available on the internet.

The nitrogen cycle is much the most complicated aspect to assess, and the figures I have used are broad-brush. For manure use I have used a number of sources, in particular N Lampkin, *Organic Farming*, Farming Press, 1990; ASAE, *Manure Production and Characteristics*, American Society of Engineers; and Chorley, G, "The Agricultural Revolution in N Europe, 1750-1880: Nitrogen, Legumes, and Crop Productivity", *Economic History Review*, 1981. The 6:4 ley:crop rotation is also taken from Lampkin 1990; a 5:2 or 7:3 rotation might be easier to achieve and this would mean that the organic livestock option would require more land for green manure The figure for human sewage represents half the total nitrogen available from the population's excrement — and twice the amount per person that Wessex Water is currently obtaining from 2.5 million customers. This may be optimistic.

Forestry figures from Forestry Commissions Statistics, http://www.forestry.gov.uk/statistics; and E Agate, *Woodlands: A Practical Handbook*, BTCV, 2003

The performance of grass-only organic dairy cows in Table F, after discussion with farmers and agronomists, I have assessed at 3,700 kilos, allowing 500 kilos for the calf. Stocking rate is one productive cow to the hectare, with each replacement also requiring a hectare. This is generous compared to Mellanby's cows which produce 3.666 kilos of milk each from chemically fertilized grassland at an average rate of 1.8 cows-plus-followers per hectare.

Further details about how I have derived these figures are available on request. No doubt there are flaws and inconsistencies in the calculations and would be grateful to hear from anybody who identifies any. But really, the subject requires studying in greater depth by university researchers.