Outline of a Food Chapter for the Resilience Plan for Norwich

See revision history

1. Purpose of this Paper

This paper is intended to become the Food Chapter of an Energy Descent Action Plan (EDAP) for Norwich. This is a key document for Transition Norwich, and will set out Transition Norwich's vision of what needs to be done to create a more resilient Norwich in the face of peak oil, climate change, and economic dislocation.

This chapter is the "property" of the Food Theme Group of Transition Norwich. Much of the work of editing the document and overseeing its development is being undertaken by Tully Wakeman of East Anglia Food Link (EAFL). .

Our hope is that this Chapter can serve several purposes, including

1. Informing the work of the Transition Norwich Food Theme Group in designing and delivering practical food projects in the short to medium term that contribute to resilience
2. Helping local authorities to consider what would need to be done to make Norwich more resilient in the medium to longer term - for example, which essential equipment is lacking and how those gaps could be filled.
3. Helping citizens understand how their own buying and eating patterns contribute to a resilient food system or otherwise.
4. Contributing to the thought process in other places about what an energy descent plan for food should contain (including by making our spreadsheet freely available). In turn we have drawn on work done elsewhere, which is referenced below.

2. Problems with our Food Supply

This section needs to be completed but will point to the increasingly-familiar threats of peak oil, climate change, economic dislocation, peak phosphate and potassium, water shortages etc. It will also refer to a section elsewhere in the Energy Descent Action Plan about demographics: there are questions about whether the population of Norwich might increase or decrease as a result of climate-driven immigration, the thinning out of London and so on.

3. Literature Review

In this paper we will refer to a number of previous investigations into how Britain can be fed. These include

- Kenneth Mellanby's book *Can Britain Feed Itself* published in 1975
- Simon Fairlie's review of Mellanby's work in the article *Can Britain Feed Itself?*[1]
- Colin Tudge's various books, most recently *Feeding People is Easy*
- Carolyn Steele's *Hungry City,* in which she identifies how central food has been to shaping cities. This is also a very useful account of how cities were provisioned in the past.
- The very good discussion of food (including in relation to energy production) in the Centre for Alternative Technology's *Zero Carbon Britain* report

Mellanby makes the point - echoed by almost everyone looking at these issues - that feeding Britain would not be difficult if we reduced our consumption of meat. Mellanby's calculations are very useful (albeit, as he anticipated, yields particularly of grains have risen very significantly since 1975), and his insights into how to think about the problems are also generally spot-on. If there is a weakness in his argument it would be the fairly scant attention he pays to the nutrients needed by plants. Writing at a time when artificial fertilisers are widely available and celebrated, he tends to assume that any crop can be grown on any arable land, without really considering the effect of different crops on nutrient levels, and therefore the structure of an organic rotation. Mellanby does note that artificial fertilisers will in due course become scarce, but he does not really carry that thought forwards into his calculations.

Simon Fairlie updates Mellanby's calculations to include the higher yields now being achieved for grains. Like Mellanby he concludes that Britain will have no problem feeding itself as long as we reduce our meat and dairy consumption. He raises the interesting question of whether a diet that includes a significant amount of meat and dairy (albeit involving much less livestock than we consume now) may in fact be more efficient than a vegan one. He argues that, while the vegan diet uses less land, the saving is mostly in grazing land; and he suggests that this land may have no other food-production purpose. He also rightly points out that livestock can consume crop wastes, such as the seedcake that is left after oilseeds are pressed, that would otherwise go to waste. Fairlie talks about a "permaculture" approach, by which he means that his plan recognises the need to produce some fibres (wool and/or flax or hemp for linen) and some wood for heating homes (he suggests 18 million tonnes, which he indicates should be enough to heat 6

million well-insulated family homes). Like Mellanby, however, Fairlie seems to play down plant nutrition and thus the details of the arable rotation.

Zero Carbon Britain takes the need for woodfuel much more seriously. Unlike Mellanby and Fairlie, CAT's investigation is a multi-dimensional one, not focussing solely on food but also on how energy for heating, transport etc can be provided from renewable sources within the UK. CAT's conclusion is that around half of the land that is currently used for agriculture can and should be used to produce wood for fuel.

The main difference between this paper and those named above is that this one attempts to focus on a particular place - Norwich - and discuss what those broad-brush pictures mean for the particular food system of that particular place. In doing so we acknowledge that the particular can only be discussed in the context of the whole.

All of the above investigations come from an "environmentalist" perspective. They tend to assume that the world's carrying capacity is finite, and that consumption needs to be fitted within what it is possible to produce. This is not the mainstream, industry-based view. In recent months a number of statements, conferences and reports from industry bodies, and the public-sector agencies that exist to support the industry, have suggested that continuing growth in consumption needs to be taken as read. "Feeding Britain", a report compiled by the Smith Institute from contributors from various parts farming industry bodies, was released at a conference in March 2009. It suggests that world food production will have to be doubled by mid-century, in order to accommodate the trends of rising population and increasing meat consumption per capita. The East of England Development Agency suggested, at its round of East Anglian agricultural fairs in summer 2008, that since land is being lost to agriculture, yields per hectare may need to triple. Neither organisation pauses to question this assumption. Their conclusion is that new ways to increase yields need to be found; that, since conventional approaches to increasing yields are petering out, genetic modification must be the only way forward.

4. Population of Norwich

The population of the City of Norwich is 121,550 (according to the 2001 census) and the land area is 4,056ha.

However, Norwich as we would generally understand it includes a number of suburbs which in administrative terms are located in adjoining districts: Costessey, Cringleford, Hellesdon, Old Catton, Sprowston, Thorpe St. Andrew and perhaps Trowse. If we include these in our definition of Norwich the population becomes 178,847 and the land area 7,860ha.

Moreover, Norwich, as well as being the main centre of Norfolk, is also a market town. A number of villages around the city naturally look to the city as the centre of their food economy. A food plan for feeding Norwich really needs to feed these villages too. We have attempted to identify villages which are nearer to Norwich than they are to the nearest market towns - Aylsham, North Walsham, Acle, Bungay, Wymondham, Dereham and Reepham. (Of course this

list is a bit arbitrary - if Reepham is counted as a market town, why not Long Stratton - but if we counted Long Stratton, what about Poringland?) Based on this list we estimate that there are 48 parishes[1] in the "hinterland" of Norwich. These bring the total population of Norwich-plus-hinterland to 232,778 and the area to 38,195ha. Around 22,500 of this consists of farms - see below.

5. How Much Land is Available to Norwich? What is our Ambition?

The thoughts of the above writers help to frame our *question* in this Chapter: how much land should Norwich aim to feed itself from? In fact, this question turns out to be the most interesting and the least easy to answer. It is relatively easy to calculate the maximum food output that can be achieved from a given area of land; but more difficult to decide what is the appropriate area of land to consider.

One approach would be to aim for, say, the county of Norfolk to be self-sufficient in food. This would be a very easy target to meet, and would probably demand no change at all in our agricultural practices or most of our eating habits. The reality is that Norfolk is over-endowed with land relative to its population. In particular, London, 100 miles to the south, has a population of 8.8 million (around 14 times the population of Norfolk) and virtually no farmland. At the very least Norfolk needs to take on the responsibility for feeding a significant fraction of the population of London - meaning that Norfolk should aim to feed a population perhaps 2-3 times the size of its own population.

Another approach would be to assume that Norwich, with its population of 233,000 people (see below), is entitled to rely for its sustenance on 233,000 / 60,000,000 of the farm land of the UK. But not all land is of the same quality. Much of the land around Norwich is good arable land, whereas other parts of the country have land of a lower quality, some of it only suited for grazing.

One way of assessing the relative quality of land is to use the Agricultural Land Classification. This categorises land into "grades", with Grade 1 being the best, most versatile and most productive land and Grade 5 being land that is really only useable for rough grazing (such as river valleys and steep hillsides). The map below[2] shows the land classification for the area

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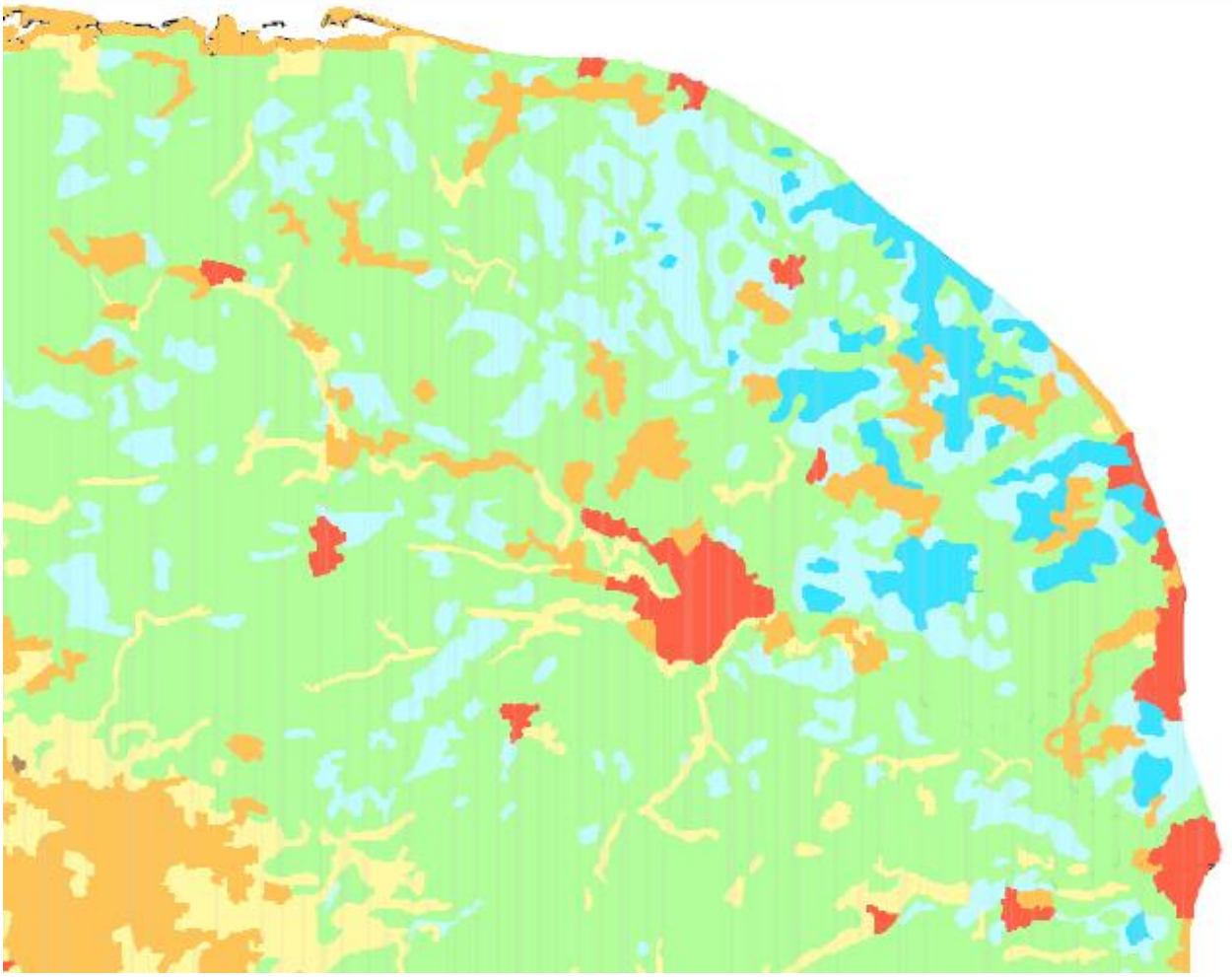
1. Alpington, Ashby St. Mary, Attlebridge, Bawburgh, Beeston St. Andrew, Bergh Apton, Bixley, Bramerton, Caistor St. Edmund, Carleton St. Peter, Claxton, Colney, Crostwick, Drayton, Easton, Felthorpe, Framingham Earl, Framingham Pigot, Frettenham, Great and Little Plumstead, Hainford, Hellington, Holverston, Horsford, Horsham St. Faith and Newton St. Faith, Horstead with Stanninghall, Howe, Keswick, Kirby Bedon, Langley with Hardley, Little Melton, Marlingford and Colton, Newton Flotman, Poringland, Postwick with Witton, Rackheath, Ringland, Rockland St. Mary, Salhouse, Saxlingham Nethergate, Shotesham, Spixworth, Stoke Holy Cross, Surlingham, Swainsthorpe, Swardeston, Taverham, Thurton, Wroxham, Yelverton
2. From http://www.magic.gov.uk/staticmaps/maps/alc_col.pdf

around Norwich. The bright blue areas on the map represent Grade 1 land, light blue is Grade 2, green is Grade 3 and cream is Grade 4. The orange areas represent land not being used for farming, much of it woodland. There is no Grade 5 land in the area.



However, discussion with agricultural experts leads us to understand that this classification is not, in general, the most useful way to understand the productive capacity of the land. For example, the heavy clay soils that make up a good part of the Grade 3 land are excellent wheat-growing land. Light loams are generally the best suited to growing vegetables, yet they are classified as Grade 2. One useful feature of the above map is that the land coloured cream - the Grade 4 land - mostly consists of river valleys which are indeed restricted in their use, being suited mainly for rough grazing.

The most reasonable approach, then, is probably to follow Melanby and Fairlie and simply distinguish between arable land and grazing land. According to DEFRA[3], the UK has about 18.5 million ha of agricultural land, divided into three roughly equal parts. Just over 6 million (if you include set-aside land) is currently used as arable. Another 6 million is "permanent pasture" (ie land that has been pasture for at least 5 years but some of which might be on land that could be

3. https://statistics.defra.gov.uk/esg/publications/auk/2007/table%203-1.xls

used for arable purposes). Another 5.5 million is rough grazing, including common land (ie this is land that can probably only be used for grazing, and even then is generally not the most productive grazing land). Lastly a million hectares is land not in agricultural use, such as woodland on farms. Historically the arable area has reduced over time, being around 7 million ha in the 1980s. For lack of better information we will assume that the arable area could be increased to **7.5m hectares**, leaving **10m hectares of grazing land** (rough grazing plus permanent pasture that is not really suited to arable use). However, **further work is needed** to establish whether more of the country's grazing land might be useable as arable: if so, Britain's food production capacity would be greater than the figures here suggest.

Since the UK's population is around 60 million, we could estimate that, on average, each person is entitled to the production from one eighth of a hectare of arable land plus one sixth of a hectare of grazing. Since we have identified the population of Norwich and its hinterland to be 233,000, Norwich's "share" of the UK's farmland would be about 29,000ha of arable land plus 39,000ha of grazing land.

However, if we are concerned to increase regional self-sufficiency and decrease food transport, we should assume that **people in different parts of the country will have different diets** and rely on a different balance of arable vs grazing land. This discussion is developed further in the sections below on where the woodland and the livestock should go.

Further, as Zero Carbon Britain points out, our land doesn't just need to produce food, it also needs to produce fuel and fibres. Nationwide around half of our farmland should be dedicated to growing wood, and some of it to wool, hemp or flax. In the section 6 we discuss where woodland should be located relative to farmland.

Lastly we should just note that, while the question "Can Britain Feed Itself" is an interesting one, it is only part of the broader question of whether the *world* can feed itself. Particularly as climate change starts to reduce agricultural yields in warmer countries, Britain might need to take some responsibility for *exporting* cereals etc to feed hungry people elsewhere (or else being ready to welcome those people into our country). So, while we might consider our "share" of UK farmland to be the *maximum* amount of land available to us, we should certainly try to get by on *less* land than that if we can.

6. Farm Land Around Norwich

In section 3 above we define a "hinterland" of Norwich consisting of some 38,000ha. In order to establish what farm land there is in this hinterland we consulted the Defra statistics for 2003[4]. Up to 2003 data was published down to ward level. We found that the parishes above correspond approximately to Norwich plus 28 other wards[5]. The Defra data at ward level is incomplete, because, for reasons of data protection, they avoid giving data at such a low level that individual

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4. http://www.defra.gov.uk/esg/work_htm/publications/cs/farmstats_web/2_SURVEY_DATA_SEARCH/COMPLETE_DATASETS/NUTS/nuts_excel_2005.zip

farms might be identifiable. For that reason, some of the figures given here may be under-estimates. Neverthless, it is possible to say that Norwich's hinterland includes *at least*:

- 400 agricultural holdings. Over 228 of these are very small (less than 5ha) and may in fact not be agricultural at all - for example where somebody keeps a horse on a few acres. At least 53 are farms of over 100 ha.
- 22,500 ha of land on agricultural holdings.
- 15 ha of vegetables on 8 different holdings (all of them around Berghapton).
- 3,500 ha of permanent grass plus 350ha of rough grazing
- 1,000 ha of woodland
- 12,000 ha of arable land which at the time of the survey was growing 6,500ha of cereals; 2,000ha of sugar beet; 750ha of potatoes, 400ha of field beans (for animal feed), 400ha of oilseed rape, 500ha of temporary grass and 1,500ha of set-aside.

It's clear that, even of the 22,500ha of agricultural land identified in the survey (which itself is probably an under-estimate), only 16,500ha is accounted for by the above figures for arable, grass, and woodland. For want of a better approach we might scale up these figures by about a third, implying that there may be **16,000ha of arable land and nearly 5,000ha of grass** in the hinterland of Norwich.

It's also important to remember that this data is for 2003, and that much has changed since then. For example, it may no longer be the case that there are 8 holdings growing vegetables in Berghapton.

9. Base Scenario: Feeding Norwich from its "Hinterland"

Method

Key to our analysis is a spreadsheet (available on request) showing what land should be made available for which crops and livestock. This includes describing the arable rotation to be applied in order to maintain the fertility of the land without recourse to artificial fertilisers. To do this it includes estimates of the nitrogen consumed or replaced by each crop. It also shows where crop residues are used to feed livestock. By calculating the likely yields of each activity, it shows what quantity of each food would be available to each of the 233,000 people in Norwich and its hinterland. It applies to those foods the standard nutrient tables published by the Food Standards Agency, so that the sufficiency of the diet can be established in relation to a wide range of nutrients including vitamins, minerals etc. It also attempts to calculate the nutrient output per hectare of various crops.

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5. ABBEYFIELD, BEAUCHAMP, BROADS, CATTON, COLTISHALL, CRINGLEFORD AND COLNEY, CROWN POINT, DRAYTON, HAINFORD, HELLESDON WEST, HORSFORD, KIDNER, NEW COSTESSEY, NORWICH, OLD COSTESSEY, PLUMSTEAD, RACKHEATH, ROSEBERY, SMOCKMILL, SPIXWORTH, SPROWSTON CENTRAL, SPROWSTON EAST, SPROWSTON SOUTH, ST FAITHS, TASVALE, TAVERHAM, THORPE ST ANDREW NORTHEAST, THORPE ST ANDREW SOUTH, WROXHAM

The key agricultural and nutritional assumptions embedded in this spreadsheet where developed at an "expert consultation" which EAFL organised between some of its directors and staff including Professor Martin Wolfe, Research Director of the Organic Research Centre; Bill Starling, a trustee of the Soil Association; William Hudson, an EAFL team member and farmer by background; Dr Marie-Ann Ha, our nutritionist; and Tully Wakeman, co-ordinator of EAFL.

The "base scenario"

As we have noted above, the most difficult questions in this investigation relate to its framing: how self-sufficient should Norwich aim to be? How much responsibility should it take for feeding London, and how much for feeding populations (currently) residing in other countries? Should we aim to be self-sufficient in wood?

We found it helpful, in framing our thinking, to identify a simplified "base case" in which Norwich seeks to provide all of its essential food - but none of its wood - from its "hinterland" as described above, that is, parishes within a radius of approximately 6 miles from Norwich, which are closer to Norwich than to other market towns. This area has a population of 223,000 people and includes, we estimate, about 16,000 ha of arable land and 5,000 of grazing.

A sufficient diet

The spreadsheet shows that this area is perfectly sufficient to provide a basic diet for the identified population. Features of the system of agriculture suggested by the spreadsheet include:

- Food production is, naturally, geared towards food for human consumption rather than growing feed for livestock. As Mellanby points out, it is far more efficient to eat crops such as beans and cereals ourselves, than to feed them to animals and then eat their meat or drink their milk.

- Our base scenario does include some livestock in places where arable crops can not be grown. This is the 5,000 ha of grazing (which for now we are assuming is all on land not really suited to arable production), and also the temporary grass/clover leys necessary to build fertility in an organic rotation. These pastures are equally split between cattle (which are dual-purpose cattle producing both milk and beef) and sheep. We have allowed for oilseed cake (the by-product of producing vegetable oils) to be fed to dairy cattle as a high-protein supplement to boost milk production.

- We have also included some chickens and pigs on the assumption that these will be fed on waste foods, whether from the kitchen or higher up the food supply chain. This is not the intensive, big-shed rearing with which we are currently familiar: chickens will mostly be in gardens, pigs either in gardens or in small herds on farms.

- Our arable rotation includes wheat, oats, beans, flax/hemp/rape for oil and fibres, potatoes and other field-scale vegetables, very small amounts of barley and sugar, and 2

years of clover/glass ley with livestock. *We need to do more analysis to check that this intensity of rotation could be sustainable.*

- In addition to vegetable production as part of the arable rotation, we have assumed that a good deal of vegetables will be grown on gardens and allotments in the city. We have allowed for around 1,000ha of such production. This is probably feasible but would require a fairly determined effort to convert existing green space to vegetable production.

- Lastly we have included a few hundred hectares of orchard.

Our tentative conclusions so far are that this pattern of production would fully meet the nutritional needs of our identified population. As others have pointed out, the constraining nutrient is the amount of energy that can be supplied: the above production produces 2,250 calories a day, which we consider to be sufficient if properly shared across the population, with active adults receiving more, children and the elderly less and so on.

Other nutrients are much less problematic: the above diet includes more than enough protein, and generally considerably more than the RNI for all the vitamins and minerals. The one exception is vitamin D, where the above diet supplies only about 1ug per day, compared to the RNI of 7ug. However, this RNI figure is controversial, because humans manufacture vitamin D, given exposure to sunlight. We are inclined not to be overly concerned about this one vitamin.

Building out from the Base Scenario

The conclusion from the base scenario is overwhelmingly optimistic. We have noted that Norwich's "share" of the UK's agricultural land is about 29,000 ha of arable land plus 39,000 ha of grazing. But we have demonstrated that we could meet our basic nutritional needs from the hinterland of Norwich, which includes only 16,000 ha of arable and 5,000 of grazing. This leaves the quesions of what we should do with the remainder of our "share" - but also where that "share" is located. It's not entirely obvious that our "share" is all located around Norwich.

Options for using the rest of our "share" include

- Feeding London. This isn't so much an issue of using "our" share of the land to feed London - that population has its own share - but rather of how the logistics of feeding London overlap with the logistics of feeding Norwich. It might (or might not) make sense to use land around Norwich to contribute to feeding London.

- Producing wood. As we discuss further below, the tension is between growing wood close to Norwich, which provides a more secure supply but demands using good arable land; or making use of lower-grade land, currently used for grazing, but potentially elsewhere in the UK.

- Producing more meat and/or dairy produce. For example, "our share" of the grazing land might be in the west country, from where cheese might be sent to us by rail.

- Producing more of a surplus of food to feed people currently resident in other countries.

- Allowing more space for wilderness. We have some questions about this approach, but it's a popular consideration in some of the literature.

7. Where should the Woodland Go?

Following CAT's lead we have suggested that half of the country's land should be used for growing trees. But the question remains, which land should be used for agriculture and which for trees? A number of issues need to be considered here:

1. Some land might be unsuitable for arable cultivation, but nevertheless be suitable for growing wood, either as coppiced willow or traditional woodland. In East Anglia this might apply to the river valleys - although many of us would regret the loss of the area's most beautiful landscapes. Also the biggest woodland in these parts, Thetford Forest, is located on very sandy, light soils which are not our best arable land. Elsewhere in the UK we seem to have more grazing land than arable land (see above), and we should at least investigate whether we should focus more of our wood production on that grazing land (since this is less productive in terms of food production) than on the relatively scarce and precious arable land. It is no doubt the case that high-quality, arable land will produce better crops of wood than poorer-quality, grazing land will. But the arable land will produce *several times* the food (in terms of calories per hectare) that the grazing land, so the argument is still in favour of using the arable land for food and the "grazing" land for woodland

2. Rather in competition with this approach is the argument for "local wood". This might suggest that an area like Norwich should be self-sufficient in wood, to avoid hauling the wood over unnecessary distances. It's easier to move a tonne of wood than a tonne of food, so one might imagine towns and cities being surrounded by a food-producing belt of a few miles' radius, and then beyond that a belt of forestry. This approach would imply that woodland should be evenly distributed across the UK - or even that it should be more concentrated in areas of higher population, such as East Anglia and the South East - but of course these are the areas that also need the most food.

3. Somewhat in competition with both of the above approaches is that of **agroforestry**. This is the practice of combining, or interweaving, forestry with agriculture. Professor Martin Wolfe, of the Organic Research Centre, has developed an approach to arable agroforestry at his research farm in Suffolk. Here he has planted rows of trees, running north-south, with wide alleys of arable land between them. The alleys of arable land are wide enough for large tractors and wide ploughs to work efficiently. The trees run north-

south to minimise the effect of shading the crops. The trees are a mixture of fruit trees, nut trees, willow coppice, and large standard trees. More research is needed, but early indications (after 15 years) suggest that, while crop yields are reduced by perhaps 20%, the yields from the trees are around 40% more than would be found in a purely woodland setting. The overall productivity of the combination is therefore greater than for trees or crops alone. There are other significant benefits in terms of biodiversity, sheltering for animals, production of nuts and fruit, and the ability of the trees to pull up nutrients from deep underground and scatter them in autumn onto the cropland.

4. A fourth consideration is that woodland may not earn as much money for the farmer/ landowner as farmland. This begs questions about who will dictate what land should be converted to wood - or whether the market will somehow sort this out. It might be easier to "share the pain" by requiring every farmer to devote a certain percentage of the land to woodland, than to pick on farmers in particular areas and tell them they have to become foresters.

As we have noted, the above approaches are somewhat in tension with each other, and much more research and experimentation will be needed to determine which is the most appropriate approach. For our purposes we could assume a compromise in which land around Norwich is dedicated to an arable agroforestry model, implying that perhaps one quarter of the land is used for trees of various types, for the production of wood plus nuts etc. We will assume that, in areas of the country with less good arable land, a greater proportion of the land will be used for forestry.

8. Where should the livestock go?

We know (and this exercise amply demonstrates, below) that arable crops grown for human consumption yield far more food per hectare of land than does land used for grazing, or meat from livestock fed on arable crops such as cereals and pulses. Mellanby points out it is highly inefficient to convert foods (such as grains and pulses), which could be consumed by humans, into meat first. The poultry industry will argue that chickens, in particular, are amazingly efficient converters of grain and pulses to meat: if the rations are properly balanced, and the chicken's movement restricted, up to half of the weight of the food is taken on by the chicken. However, as Melanby points out, the weight taken on by the chicken is 50% bone, feather, skin and other inedible parts, so only a quarter of the feed is actually converted into meat. Moreover, the weight of the meat includes some 70% water, whereas the grain did not. Thus Melanby argues that even these most efficient feed-converters only convert one-twelfth of the feed. Similarly he suggests feed conversion ratios of 20:1 for pigs and 30:1 for cattle. Milk and eggs are rather more efficient, and he suggests we favour these over meat, but still that we limit our production of them.

Our spreadsheet, below, calculates the food produced per hectare in terms of the energy (calories) that food makes available, as well as protein and other nutrients. These figures reinforce Melanby's point.

With this in mind, we propose that the most efficient use of land will be **to use as much good, arable land as we can to produce plants for consumption by humans, and to fit in livestock only where there is land or feed that has no other value for producing food for humans or for fuel wood etc.**

This approach leaves three "niches" where livestock naturally fit in our farming system:

1. As part of an arable rotation. Absent artificial fertiliser, it is necessary to allow one, two or more years of grass/clover ley as part of the arable rotation, in order to replace the nitrogen that has been removed by growing wheat and other nutrient-hungry crops. This ley can be grazed by cattle or sheep. Of course, in grazing it they remove some of the nitrogen and convert it into protein in their bodies or milk; but much of it is returned to the soil. This seems to us to be an efficient use of land to produce food.

2. Where there are wastes from crops or food. At present a vast amount (perhaps one third to one half) of the food we produce is thrown away. In future it is essential that this waste be greatly reduced, and that humans eat whatever it is possible for humans to eat. Nevertheless, households will always have peelings and other unavoidable wastes that might be fed to chickens in the back yard or a nearby pig. Farms and food production processes also create wastes, as for example where oilseeds are pressed and leave behind an excellent high-protein seed-cake. The best use of these wastes will be to feed them to livestock.

3. Where there is grazing land that has no other good purpose, or possibly where its landscape value is so great that we are willing to preserve it even at the cost of some food production. We have noted above that much of the land currently used for "rough grazing" might be in this category. Around Norwich this generally means our marshy river valley bottoms.

We can therefore say with some clarity where livestock should be kept. Sheep and cattle will be kept on grass leys as part of the arable rotation. Cattle may also be grazed on the marshes. Pigs and chickens will be fed on scraps and should be kept close to the source of those scraps, including in back gardens.

10. Food Distribution and Processing

As well as having resilient agriculture, we also need resilient systems for distributing, storing, processing and retailing food. The supermarkets, and the large companies they depend on in their food supply chains, may or may not survive peak oil and the associated economic downturn. Small, locally-owned businesses which have not been built on borrowed capital may be better-placed to weather these storms.

The purpose of this section of the document is to describe the most resilient approach we can think of, to the distribution and processing involved in getting the following categories of food from farm to fork.

10.1 Bread

What are the weak points in the current bread supply chain? (Transport of flour from distant mills, transport of bread from distant bakeries, single point of supply for yeast…) If we were to build a local infrastructure that would be more resilient, on what scale would it be needed in order to feed Norwich? How much wheat would be needed? How big a grain store? How big a mill, or how many mills of what size? How many bakers? What weak points would remain (eg reliance on electricity or gas for milling, baking)?

Production: Let's assume our "arable ecological diet" calls for a quarter of a large loaf (ie 4 slices) of wholemeal bread per person per day. That's 200g of bread per day so about 135g of flour. So the 233,000 people in Norwich and its hinterland need 31.5 tonnes per day of wholemeal flour, or 11,500 tonnes per year.

Storage: If we wanted to store a single year's supply of wheat in Norwich we'd need a grain store capable of holding 11,500 tonnes. Norwich is likely to have an excess of suitable barn-like space in the form of the "retail warehouses" that have been built in recent years. For example, Woolworth's store on Riverside has a floorspace of 8,616m^2. So if we filled that space to an average height of 1.33m it would hold a year's supply of wheat. Riverside is an excellent location in terms of its access to both rail and river for transporting the wheat; but flooding could be a problem, so higher locations should also be considered.

Milling: Equipment will be needed to dress (clean) the wheat (ie remove stones, weevils etc) and then to mill the wheat. A typical windmill or watermill mills around a tonne a day. The electric mill that we propose to buy for Norwich (see projects below) would have a similar throughput, would cost around £4,000 (probably double that once the associated equipment has been added), and stands about 1m square. However, 30 such mills would be needed to mill the 30 tonnes per day that Norwich needs.

Bakers: according to the Bakers' Federation, Britain consumes the equivalent of 12m loaves of bread per day (actually a little less than a quarter of a loaf per person). Three-quarters of this bread comes from the big plant bakers, around 20% from supermarket in-store bakeries, and only 5% from craft bakers. In the case of Norwich and its hinterland we might calculate that the population of 233,000 is consuming around 47,000 loaves a day, of which 35,000 will come from the big plant bakers, 10,000 from supermarket in-store bakeries, and only around 2400 from the area's 20 or so craft bakers. (In France, where artisan-baked bread is more important, it's interesting to note that for example Aix-en-Provence, with the same population as Norwich, has over 60 artisan bakers.)

The plant bakery sector is dominated by two companies - Allied Bakeries (ABF) and Hovis

(Premier Foods) - with Warburtons in third place. Allied Bakeries' nearest production site is in Stevenage (91 miles), Hovis' in Forest Gate, East London (107 miles) and Warburtons' is in Enfield (107 miles).

Supermarket in-store bakeries offer the potential of a more useful contribution to a resilient bread supply in that most of them have the necessary equipment to bake bread from local flour (mixer, bread oven etc).

However, even if supermarket bakeries can be repurposed to form part of a resilient local bread supply chain, Norwich would still need many more bakeries - perhaps 100-200 more - if it were to stop importing bread from distant plant bakeries.

10.2 Beans and lentils

What are the weak points in the current supply chain? (almost all imported from China and USA). If we were to grow them locally, what new infrastructure would be needed, on what scale, to store the beans, clean them for human consumption etc? What weak points would remain? (Easy to grow beans, an excellent addition to an organic rotation as they do not take nitrogen from the soil - they even add a small amount to existing levels - and the main processing needed is a cleaning machine to shell the beans, remove stones etc.)

10.3 Oats:

Again, what are the weak points currently, how would we scale a new system to feed Norwich? (Easy to grow oats but we need to provide local processing, ie rolling. Not a huge problem and we should build a pilot plant asap.)

10.4 Vegetables

Weak points currently (very consolidated large-scale production in a very few geographical areas; reliance on frozen and canned veg with high environmental impact reliant on inputs of energy, materials and capital). Models for much more resilient distribution, focussing on own production (gardens and allotments) plus urban and near-urban production (market gardens, root vegetables as part of an organic rotation on nearby organic farms). Role of greengrocers' shops, community supported agriculture, wholesale market, street markets. How many of each would we need to feed Norwich?

10.5 Meat

Weak points currently (reliance on imported feed, notably soya which has a devastating impact on rainforests etc). Capacity of existing abattoir provision (Blakes at Felthorpe) to handle enough meat to feed Norwich at much-reduced levels of meat consumption. Capacity of existing butchers ditto.

11. Nutrient recycling

All food production requires basic nutrients (including nitrate, phosphate and potassium) to be provided to the plants in some way – since these nutrients are taken off the field every time a crop is harvested. Nitrate can be replaced using nitrogen-fixing plants such as clover, but phosphate and potassium can not. In the past this has been remedied by mining mineral phosphate and potassium (ie rocks) and adding them back to the fields. But this is becoming difficult as supplies of these minerals are becoming exhausted. It also represents a key "weak point" for our entire food system in the event that international trade breaks down etc.
With particular reference to potassium and phosphate, this section should consider where nutrients get lost in the food supply chain – for example as animal manure, animal carcass waste, waste from retail outlets, waste from the kitchen, human waste (liquid and solid).
It should then consider how nutrients can be retrieved from those wastes and returned to the land. (For example, most solid residue from sewage works now gets returned to farm land, but liquid wastes may not. Would a system like a reed bed work better? How big a reed bed would we need to recycle all the sewage from Norwich?)
Critically, nutrients need to be returned to the same land on which the crops were grown. It is not sufficient to put all the nutrients from Norwich's sewage on land immediately around Norwich, if some of the crops used to feed Norwich were grown further away. This might prove to be a critical limitation on the distance on which food can travel to market, and we'd like to understand more about it.
Note that there is a "hook" here to the Waste chapter of the EDP when it eventually gets written.
Research method: I'm hoping there may be people at UEA with a better grasp on these issues than I have!

12. Reskilling

Steps to build skills in growing (domestic and commercial), baking, cooking etc.

13. Policy Changes and the Role of Government

Based on the above scenarios, what changes might be needed to public policy (at national, regional or local level) to facilitate the kind of resilient food system that will be needed?
Examples might include

- Re-instatement of Land Settlement Associations, which provided smallholdings to people who had undergone agricultural training. A collaboration between the County Farms Estate and Easton College (land-based college) might do much to facilitate this.
- Changes to planning policies to allow the building of new homes on smallholdings, particularly close to Norwich where fruit and veg production will be most appropriate.
- Possibility of public ownership of grain reserves, bean reserves etc sufficient to carry the population through crises of a year or more. Possibility of subsidising storage facilities,

mills etc either in Norwich or connected in a resilient way to Norwich (because providing for emergencies is a “market failure”).
- Changes to Animal Byproducts Regulations to allow waste food to be fed to pigs and chickens, residues of bones etc to be returned to the land as fertiliser and so on.

14. First Steps

Transition Norwich is already working on a number of pilot projects etc which we hope will begin to illustrate the potential of more resilient food systems. These include

1. The city farm(s) (potentially a number of sites around the city illustrating different aspects of food production, which we hope will include a forest garden at UEA and a larger, more commercial market garden at the Hewett school)
2. Community supported agriculture
3. Releasing land just outside the city for small-scale market gardening
4. The bread project (linking very resilient, composite cross population organic wheat to local milling, artisan bakers in Norwich, and retailers in Norwich)
5. The beans project (researching varieties of beans and lentils that can be grown in the area, getting organic farmers to grow them for wholefood shops etc in the city and beyond, trialling different ways of preparing them for consumption)
6. The oats project (investigating and investing in processing equipment appropriate for turning locally-grown organic oats into the product we like to eat for breakfast)
7. The neighbourhood markets project (seeking to establish new informal markets along the lines of Country Markets, ie where people can sell home-produced veg, bread, cakes etc).

This section of the document will describe the plans and any progress made with these.
Research method: discuss with members of TN Food Group and/or draw on existing documentation, project plans etc that EAFL can provide.

15. Links to other Chapters of this Energy Descent Action Plan

1. Energy. The food system outlined in this plan is designed to minimise its reliance on energy sources other than the food crops themselves. But energy will still be needed - to power tractors and trucks, to dry grain, to power mills (eg Duffields' mill at Saxlingham Thorpe has a 2,000kva supply for its 130bhp motor), and to fire bakers' ovens.
2. Waste. Crops need macronutrients (nitrogen, phosphorus and potassium) as well as many micronutrients to grow. When crops are harvested and removed from the field, those nutrients are lost to the field. Nitrogen can be replaced by growing legumes, but all the other nutrients need to be either recycled or replaced from mineral sources. Mineral sources are non-renewable and all the evidence is that important minerals such as phosphorus are now in depletion (ie "past peak") worldwide. So recycling is the only option. This means that nutrients must be recovered from human waste (both solid and liquid), but also from every other process where a crop is processed, from abattoir waste

to wood ash to vegetable peelings. And those nutrients must be returned, not just to land in general, but to the land from whence that crop came. This may be possible to imagine where food and fuel from the hinterland of Norwich is being used in Norwich, but harder where cereals are being sent, say, to London. (Yet Norfolk does need to contribute in a big way to feeding London.)

3. Reskilling and Education. This chapter has included some observations on the skills needs of present and future generations in relation to growing and preparing food.
4. Business and Economy, particularly in relation to the idea of a food-backed local currency, and the reality that in future many more people are going to be involved in growing and producing food as part of their livelihood.
5. Heart and Soul, in relation for example to the opportunities for building community around producing and sharing food.
6. Water. We don't have a theme group for this yet, but clearly it's a key requirement for food production.

Footnotes:

1 Available on the Transition Culture website – see http://transitionculture.org/2007/12/20/can-britain-feed-itself/

3 Downloadable from the Transition Culture website among others

4 See for example http://www.defra.gov.uk/corporate/ministers/speeches/hilary-benn/hb081210.htm

5 ie any system of farming that minimises its reliance on external inputs, as we can not assume that these will continue to be available in the face of resource depletion, economic downturn etc.