Can Totnes and District Feed Itself?
Exploring the practicalities of food relocalisation.

Working Paper Version 1.0.

Rob Hopkins, Mark Thurstain-Goodwin and Simon Fairlie.

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1. Introduction

Interest in local food has grown steadily in recent years, with people seeing not just its nutritional and taste benefits, but also its political role, alongside its ability to strengthen local economies. Increasingly, movements such as the Transition Network[1] are seeing, in the light of climate change and resource depletion, that the role of local food is no longer an optional extra, but a key necessity in a resource-constrained future. In the wider context of economic localisation, economist David Fleming writes, "…localisation stands, at best, at the limits of practical possibility, but it has the decisive argument in its favour that there will be no alternative" (Fleming 2006). This paper explores the degree of relocalisation in the food sector that might be possible, through an unprecedented drawing together of the concepts of 'foodzones' and 'foodsheds', as well as Simon Fairlie's work on 'Can Britain Feed Itself?' It utilises GIS (Geographical Information Science) technology and a range of datasets to look at Totnes and District in Devon, England, to assess the degree to which the area could be self reliant for food and other essentials. Totnes and District is chosen for this paper as it is home to Transition Town Totnes, the first such project in the UK, and this paper is part of a larger project into food relocalisation that they are undertaking.

The research and findings presented here are very much work-in-progress, and raise many areas for further research. Many of the key datasets that a thorough version of this work would need are not in the public domain and are prohibitively expensive to access, some of the data around land use is out of date, and many of the statistics have to be inferred from an overlapping of several sets. However, in spite of its limitations and imperfections, the findings of this paper are fascinating, with far-reaching implications for other settlements and for the UK as a whole. The conclusions identify the need for a rethink of how agriculture is practiced, as well as the urgent need for research into new models of food production. Also identified is the need for national version of this research, a larger project, but in the light of the fast moving issues of peak oil, climate change and the economic difficulties facing the UK, a profoundly urgent one.

2. An Opening Caveat

Beginning to ask the question of whether anywhere "can feed itself" is like opening a set of Russian dolls. At which scale does one start? Can a village feed itself? A town? A city? Can Europe feed itself? Indeed, can the world? This is surely one of the key questions of our time, but where to begin? The research and contemplations presented in this paper start at the level of a small area of Devon, but by doing so, the intention is to explore the challenges and opportunities of doing the same on a national scale, a project Transition Network is planning to develop in partnership with a range of other organisations. Also, this paper just looks at food and fuel. Clearly though, there is also a need for research on whether Britain can power itself, clothe, medicate, house and furnish itself. This is a huge area of potential research but it is hoped that this paper initiates a long-overdue debate on these vital questions.

3. Why Food and Farming Needs a Plan B

It is increasingly clear that we are moving from a time in history where our degree of economic success and sense of personal prowess are directly linked to our degree of oil consumption, to one where our degree of oil dependency equates to our degree of vulnerability. This is felt nowhere more keenly than in agriculture. In

[1] www.transitionnetwork.org

the US, the food system has been estimated to require 10 calories of fossil fuel for every 1 calorie that lands up on our plates (Giampietro and Pimentel 1994). The UK can no longer rely on the assumption that cheap liquid fuels will continue to be available into the indefinite future.

The global economy is entering a world where, as a report commissioned by the US Department of Energy predicted in 2005, "liquid fuel prices and price volatility will increase dramatically", and the high prices of July 2008 (over $147 a barrel[2]) are predicted by many to be just the first of many such surges, attributed by some as being one of the principal causes of the current economic downturn (Rubin 2009). Christophe de Margerie, CEO of Total, stated recently that the economic downturn means that world oil production will be unable to exceed 89 million barrels a day (Hoyos 2009), and a growing number of observers argue that July 2008's price spike was the peak in world oil production (Oil Drum 2009). Francisco Blanch of Merrill Lynch was recently reported as saying that oil companies must find another Saudi Arabia every two years just to maintain current production levels. Referring to the July 2008 price spike, he recently said "the commodity supercycle is not over, just resting" (The Economist 2009: 76). It is clear that the next 10-15 years will see increasing price volatility, and possible interruptions to supplies of the liquid fuels that make our current economic model viable. Being oil dependent is already becoming a high risk strategy, for individuals, businesses and whole economies.

Climate change is the second issue that underpins this paper. The government has set a target of reducing emissions by 80% by 2050, based on the assumption that the aim is to stay below 450ppm. Recent research by the Tyndall Centre for Climate Change Research (Anderson and Bows 2009) argues that 450ppm actually has a 50% risk of runaway climate change, and is deeply inadequate as a target[3]. They argue that shifting the focus to cumulative emissions, leads to a shift from thinking of "long term gradual reduction to urgent and radical reduction" (ibid). What is needed, they argue, is the total decarbonisation of the economy by 2035-2045, which raises huge questions for the present-day food system. This was reflected in a 2008 Cabinet Office paper, which stated "existing patterns of food production are not fit for a low-carbon, more resource constrained-future" (Cabinet Office 2008). The task this paper sets itself is to explore what a pattern of food production that *is* fit for that future might look like, taking Totnes and District as a microcosm for that debate.

Based on the need to address these two issues, we might set out the following qualities of any system capable of feeding Totnes and District in 2030; fully contributing to the 80% or higher cut in carbon emissions by 2050

- resilient: resilience (see further below) being the ability at all levels to withstand shock, must be key, embodied in the ability of the settlement in question, and its food supply system, to adapt rapidly to rising energy costs and climate change (UK Climate Projections 2009 estimate that by 2050, the climate for the South West in 2050 will be 2-3^{o} C warmer than present, with around 30% less summer rainfall[4]).
- delivering improved access to nutritious and affordable food[5]
- delivering far more diversity than at present, in terms of species, ecosystems, produce, occupations, etc.
- providing a significantly greater source of employment than at present
- providing a very substantially enhanced carbon sink (which will lead to farming becoming more based on perennial, tree-based systems, as well as making good soil management and the return to soils of organic matter priorities)
- being more intrinsically linked to local markets than at present, both supplying and being supplied by local markets by default, reducing the need for transportation of foodstuffs and people
- providing a much-reduced dependence on fossil fuel-based fertilisers and other agrochemicals (ideally enabled by a shift to organic practices)[6]

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[2] Seeley, T. (2008) *U.S. Regulator `Closely Monitoring' Nymex Oil Prices (Update1*). Bloomberg.com. Oil touched a record $147.27 a barrel on July 11 2008.

[3] An argument also made in more depth in Public Interest Research Centre. (2008) *Climate Safety: in case of emergency* . www.climatesafety.org

[4] www.ukclimateprojections.defra.gov.uk/content/view/1334/543/index.html

[5] The concept of 'food deserts' is explored in, for example, Cummins, J. & Macintyre,S. (2002) *"Food deserts": evidence and assumption in health policy making.* BMJ 2002;325:436-438 (24 August).

[6] At present, nitrogen fertilisers are made using the Haber-Bosch process which uses natural gas.

- accompanying this will also be the need for a large increase in the amount of food produced from back gardens, allotments and other more 'urban' food sources, collectively referred to as 'urban agriculture'[7].

In essence, it is argued that the need to build a resilient food system goes far deeper than the UK Government's interpretation of the concept of resilience, which is to broaden the base from which food is sourced, rather than a focus on increased self sufficiency (Cabinet Office 2008) and which also sees resilience in the context of emergency preparedness, stating that resilience is about reducing "the risk from emergencies so that people can go about their business freely and with confidence" (Cabinet Office 2009). This paper argues that increased resilience is a potentially positive process, rebuilding food security, stronger communities, healthier food and more skilled and active communities. In the context of peak oil and climate change, the Government definitions of resilience could perhaps be seen as being about resisting change, whereas this paper argues that change is inevitable, and that this requires acceptance in order to develop a strategy to manage that
change.

Increasingly, the concept of local food, and of the 'foodshed' (Kloppenburg et al. 2006, Hedden 2009, Peters et al. 2008), or the 'urban foodshed' (Getz 1991), is helping us to conceptualise a local food economy, focusing on the need to rebuild around our settlements the food systems which supply the bulk of their needs, designed to function beyond the availability of cheap liquid fuels. Peters et al. (2008) define a foodshed as "the geographical area from which a population derives its food supply", while for Kloppenburg et al. (1996) it is "a more locally reliant, alternative food system that reduces the negative social and environmental impacts of agriculture". It is this foodshed concept, along with that of the 'foodzone' (see below), and how they could be applied to assessing the potential food resilience of Totnes and District, that underpin the rest of this paper.

4. "No Man is an Island": the concept of 'food footprints'

Clearly, one cannot look at Totnes and District in isolation. While this paper suggests a rebuilding of food resilience, and of a local food economy primarily built around meeting local needs and thereby living more within its energy budget, it is not suggesting an isolationist approach, or of somehow intentionally choosing to deny ourselves a certain amount of imports while they are available. Rather, it is about building resilience, the ability of the area to withstand shocks from the outside. A recent paper by DEMOS, 'Resilient Nation', defined resilience as "the capacity of an individual, community or system to adapt in order to sustain an acceptable level of function, structure, and identity" (DEMOS 2009: 18).

What is explored in this paper is the hypothesis that living within the food footprints set out below, were it to prove possible, need not mean a marked impoverishment of our current quality of life, a hairshirt lifestyle set in an apocalyptic worst-case scenario. Rather, what is presented here explores the potential for a new food culture, one that becomes more rooted in healthy, fresh food, with a wide variety of local livelihoods offering meaningful and productive work, with rich soils, abundant wildlife, a resurgence of skills and craft, and a renewed interest in healthy eating[8].

It would result in a more populated countryside being home to a range of businesses and a greater range of land use types, and an urban landscape fully integrating food production and intensive market gardening. It is not about "going back" to some dimly imagined rural idyll, rather it is about going forward into the future in such a way as to be able to thrive and flourish in uncertain and volatile times, and to live within realistic energy constraints.

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[7] See, for example, Drescher et al. 2000. *Urban Food Security: Urban agriculture, a response to crisis*? UA Magazine (2000) and Vijoen, Andre, et al. (2005), *Continuous Productive Urban Landscapes.* Architectural Press, Burlington MA

[8] This concept is set out at more length in Hopkins, R. (2008) *The Transition Handbook: from oil dependency to local resilience.* Green Books.

One of the most fascinating places to start this exploration of the degree to which Totnes and District could build a more self-reliant food economy is to look at its geographical context, and how the food footprints of the larger settlements adjoining the town overlap with that of the area. The term 'food footprint' refers to the amount of land in total that it would take to meet the basic food needs of a given settlement. The food footprint of Totnes town itself (that is, the amount of land required to feed its population if it were to be entirely self sufficient) covers an area of 19.4 square kilometres. This might lead one to think that given that it sits in a mostly rural landscape, building a relatively self-reliant food system is easily achievable. Figure 1 soon dispels this idea. It is built up from composite food footprints for all settlements in the South West with estimated populations of over 800 people, and is based on the assumptions that back garden space is utilised for food production and that the diet is Fairlie's Livestock Permaculture model (see Figure 7).

Figure 1: Food Footprints of settlements in the South West with a population of over 800, note location of Totnes and Dartington (http://www.geofutures.com/about/foodsecurity.html)

When one looks at the food footprint of Torquay and Paignton to the east of Totnes and District, it passes beyond Totnes heading west, passing the footprint of Plymouth, which extends nearly as far as Totnes from the opposite direction. The area we are looking at in this paper is intersected and overlapped by these two other much larger population centres. The most sobering footprint is that of Greater London (not shown in Figure 1), which extends almost as far west as Bristol, and as far north as Birmingham. Feeding the UK's cities will be a huge challenge, and raises many questions, including what degree of re-ruralisation will be required.

5. Defining Totnes and District

Totnes is a town in the South Hams in Devon with an urban population of around 8,416[9], while Totnes and District (that is, Totnes and its surrounding 15 parishes, Figure 2) is a largely notional concept, developed by the Market and Coastal Towns Initiative (MCTI), with a total population of 23,914 (15,498 excluding Totnes town) (Devon Primary Care Trust (PCT) 2008). Although its southern boundaries reflect traditional and geographical relationships based on Totnes' history as a market town, its northern border is a politically generated boundary, forming, as it does, the north-eastern boundary of South Hams district. The total land

[9] This paper defines Totnes as being the area defined in the Census as MSOA E02004191 or 'South Hams 003'

area is almost 24,000 hectares, which, when roads, buildings, water and so on are taken out, translates into around 22,000ha of land (DCLG 2005).

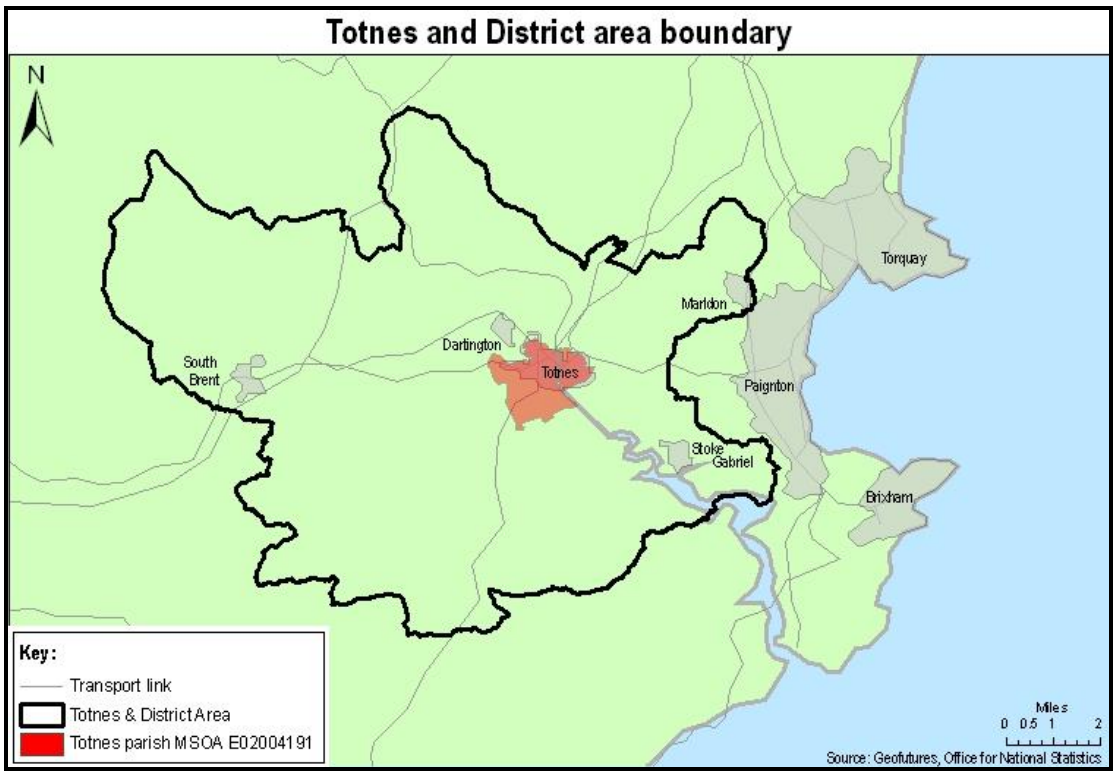


Figure 2: The boundary of the area of Totnes and District

One last challenge that a more localised food system will need to address is that of who will do the farming. It has been estimated that a post-oil agricultural community will need to employ something like 20% of its population in food production[10]. According to the 2001 Census, in Totnes and District 5.54% of people in the area work in food, forestry and fishing (although an exact figure as how many work in agriculture is unavailable) (ONS 2001). This clearly differs between the urban and the rural populations. 2.4% of Totnes work in food, forestry and fishing, while 7.33% of the rest of Totnes and District do (ibid). The other challenge is the area's age profile. Farming requires fit and able-bodied people, but Totnes and District has a more aged population than most other parts of the region, as the graph below (Figure 3) highlights;

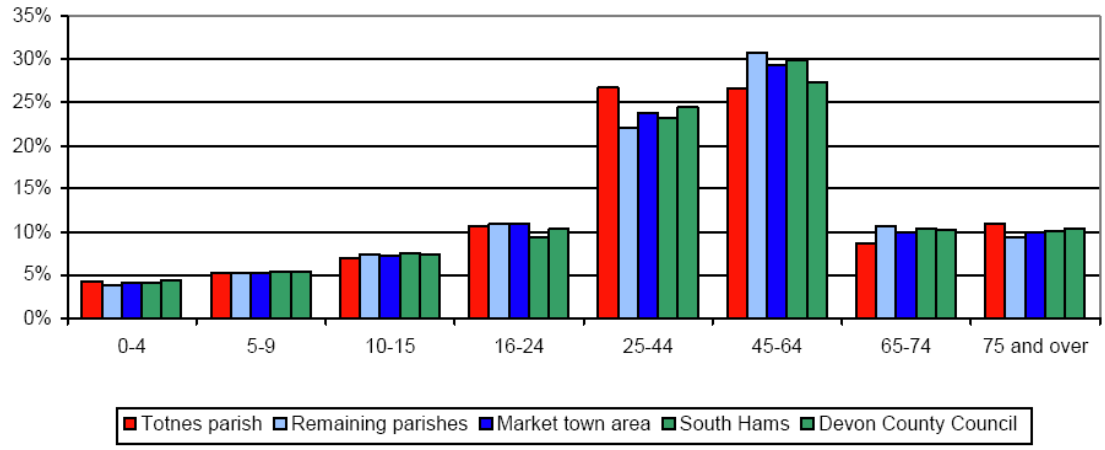


Figure 3: The population age profile for Totnes and District. Source: based on data from Devon PCT (2008)

[10] Heinberg, R. (2007) *The Essential Relocalisation of Food Production.* In "One Planet Agriculture: the Case for Action". Edited by Rob Hopkins and Patrick Holden. Soil Association. Retrieved from www.transitionculture.org/wp-content/uploads/2007/thecaseforaction.pdf

In 2008 at the Soil Association conference, Richard Heinberg looked at the increase in the number of people working in agriculture in Cuba before and after their 'Special Period' in 1990, when the Soviet Union collapsed and the country lost 80% of its fossil fuels and agrochemicals. The percentage of people working in farming rose from 1% to 20%[11]. The wider link between the availability of cheap oil and the number of people required in agriculture can be seen, for the US, in Figure 4.

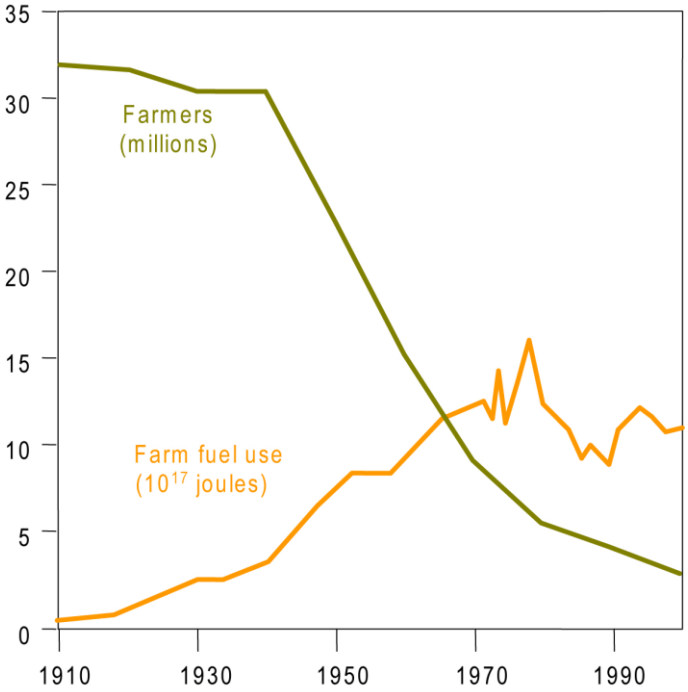


Figure 4: The US farm population and direct fuel consumption, 1910 to 2000. Much the same pattern can be observed for UK agriculture (Miranowski 2004)

For the UK, this would translate into an increase from half a million to 10 million employed in agriculture in some way[12]. More people working on the land will in turn necessitate more people living on the land. This implies a process of increased ruralisation, and also raises planning issues in terms of where these people will live.

5. The Land, and How it is Currently Used

In rough general figures, Totnes and District contains around 23,700 hectares of land (DCLG 2005). Of that, agricultural land consists of approximately 19,282 hectares; woodland and set-aside land covers around 1,273 hectares (Defra 2004); buildings, roads, water, paths, railways and 'other' account for about 1,272 hectares, and gardens around 329 hectares (DCLG 2005). Our starting point in this paper is to look at the quality of the land that is available in the area, which will in turn inform our land use options. Clearly it makes no sense to graze sheep on Grade 1 land, nor to try and grow wheat on Grade 5 land[13]. The land base beneath our feet will

[11] Hernandez-Reguant, A. (2009) *Cuba in the Special Period: Culture and Ideology in the 1990s*. Palgrave Macmillan

[12] Also explored in a talk by Heinberg entitled *'The Implication for Peak Oil on Agriculture'*, available at www.podcastdirectory.com/podshows/1119264. For a more detailed account, see Wright, J. (2008) Earthscan Books.

[13] The Defra Agricultural Land Classification divides farm land into five grades according to climate, site and soil characteristics. These can be summarised as:
Grade 1: excellent quality agricultural land, suitable for a wide range of crops including top fruit, soft fruit, salad crops and winter vegetables;
Grade 2: very good quality agricultural land, suitable for all but the most demanding crops, with yields possibly lower and more variable than Grade 1;

inevitably constrain and inform our land use choices. Figure 5 sets out the land use classes for Totnes and District.

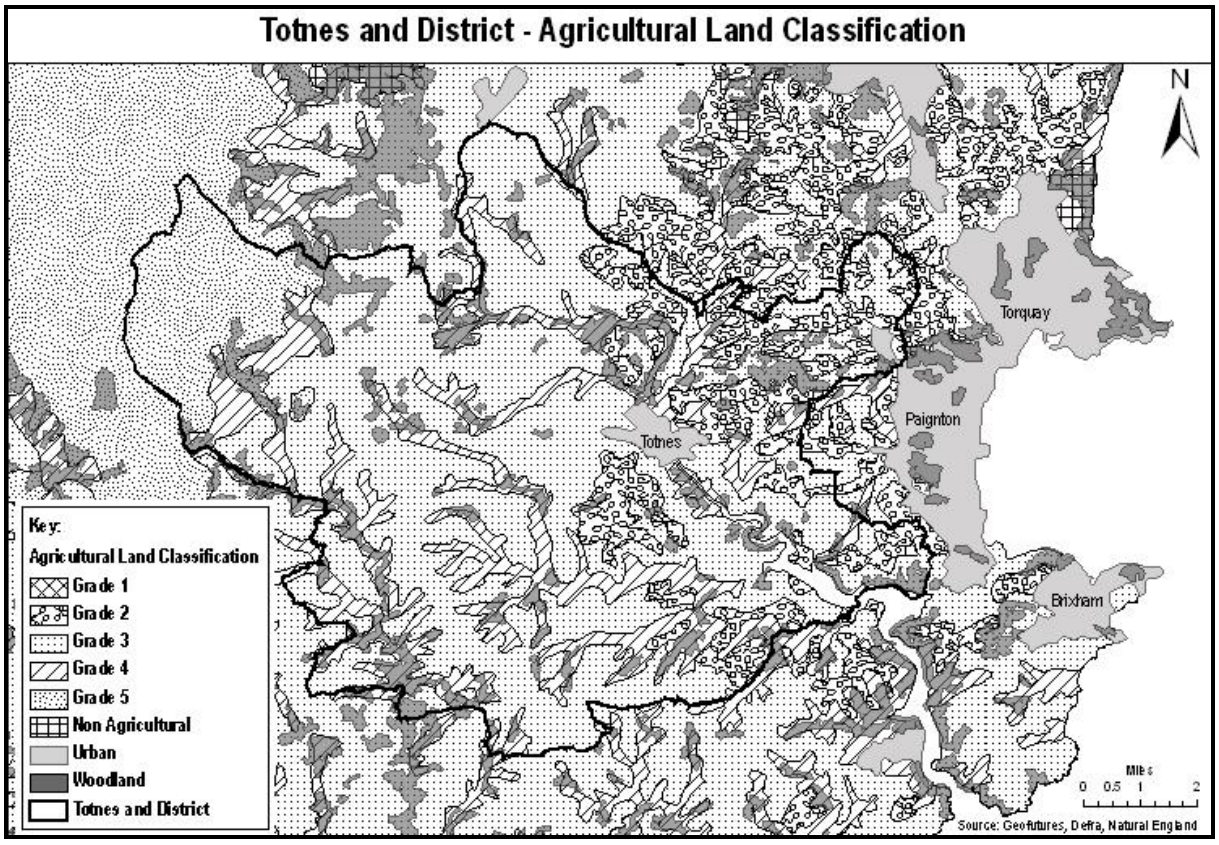


Figure 5: Land use classes across Totnes and District, showing the Totnes and District area boundary **Dates of source datasets?**

Having identified these land use classes, the next step is to pin down how land in Totnes and District is presently used. This has proven a difficult task given that the area we are looking at straddles several of Defra's data areas, but pinning this down is key to our being able to explore the potential productivity of the area. The most recent data available at a suitably granular level is that from 2004. After that point, Defra issued statistics in a more general format, and specific data is harder to come by. As a rough thumbnail sketch, based on the 2004 data, land use in the area is composed as shown in Figure 6;

Subgrade 3a: good quality agricultural land, capable of producing moderate/high yields of a narrower range of arable crops including cereals, grass, rape, potatoes etc;
Subgrade 3b: moderate quality, capable of growing moderate yields of cereals or high yields of grazing grass;
Grade 4: poor quality agricultural land, with severely restricted crop range or yield, mainly suited to grass or occasional forage crops; also includes droughty arable land
Grade 5: very poor quality agricultural land, only usable for permanent pasture or rough grazing.
Full definitions and grading methodology can be found at www.defra.gov.uk/farm/environment/land-use

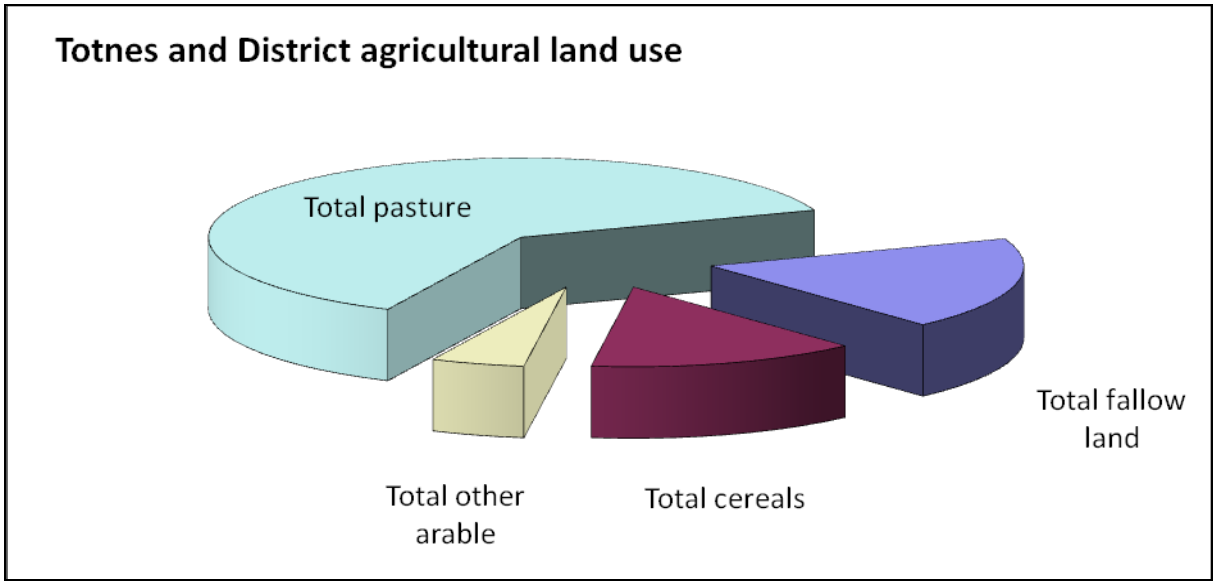


Figure 6: A general indication of land use in Totnes and District in 2004. Source: Defra (2004) June Agricultural Survey data

A more detailed breakdown is as follows;

Total pasture: 12,062 ha Permanent grass: 8,911ha Temporary grass: 2,638 ha Grazing: 513 ha **Total Cereals: 2,669 ha** Wheat: 869 ha Winter Barley: 604 ha Spring Barley: 877 ha Oats: 189 ha Other cereals: 130 ha **Fallow land:[14] 3,607ha**	**Total other arable: 944 ha** Potatoes: 34ha Beans 67ha Peas 43ha Oilseed rape 149ha Linseed 70ha Turnips 55ha Other stockfeed 70ha Maize: 295ha Other arable: 54ha Bare fallow: 9ha Total peas and beans: 1ha Vegetables (salads): 64ha Orchard fruit: 24ha Bush fruit: 5ha Nurseries: 6ha

Source: Defra (2004) June Agricultural Survey Data

In terms of the regional self-reliance this paper is exploring, it is interesting to note that the 2,669 hectares dedicated to cereals production in 2004 would yield, under organic systems, roughly 8,000 tons of wheat, enough for around 24,000 people if they ate a diet consisting mostly of wheat, but clearly able to support far more people as part of a more balanced diet.

6. "Can Britain Feed Itself" and the "Livestock Permaculture" Model

In his paper in *The Land* magazine (Winter 2007-8), Simon Fairlie asked the question 'Can Britain Feed Itself?' (Fairlie 2007). So far as the authors are aware, this question had not been asked in print since 1975, when Kenneth Mellanby wrote a book of the same name (Mellanby 1975). Fairlie identified and evaluated six

[14] Fallow land is here referred to as cropland that is not seeded for a season; it may or may not be ploughed. The land may be cultivated or chemically treated for control of weeds and other pests or may be left unaltered. (http://www.infoplease.com/ce6/sci/A0818206.html)

possible scenarios by which the nation might attempt to feed itself. He dismissed conventional organic livestock production on the basis that it is too hungry in its demand for land, and the two models that emerge as most viable are 'Livestock Permaculture' and 'Vegan Permaculture'. This paper focuses on 'Livestock Permaculture' because it is felt to be the most socially acceptable of the two. He states some of the key elements that would distinguish it from Organic Livestock;

- feeding livestock upon food wastes and residues
- returning human 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.

He acknowledges that this approach would require more labour, a more even dispersal of agricultural workers around the country, and a more localised economy with some degree of agrarian resettlement. As he puts it, the purpose of this model is;

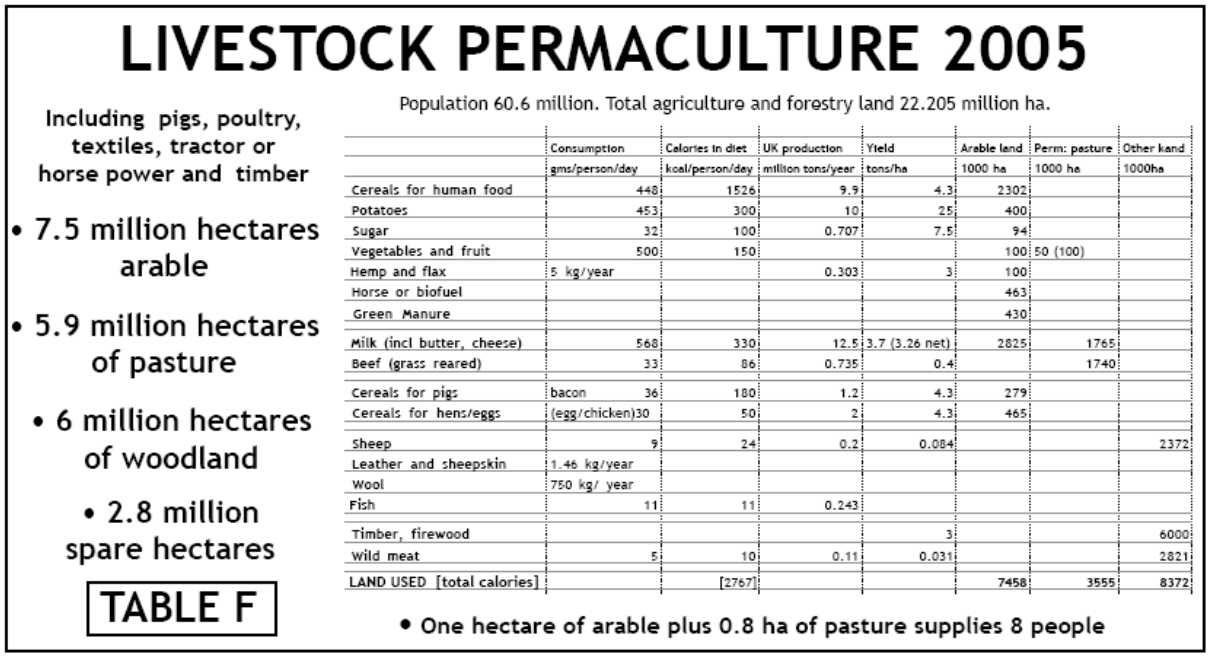
> *"... to go another step further and see whether the UK could become more self reliant, not only in food, fodder and fertility, but also in fibre and fuel? Our environmental footprint currently stretches across untold ghost acres across the world; if suddenly we had to shoehorn it into the 22 million 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?"*
>
> (Fairlie 2007: 22)

The 'Livestock Permaculture' scenario features the following elements;

- It aims to provide 2,767 calories per person per day
- Meat is produced to meet demand at 1975 levels (around 83 grams of red meat per person per day, for a family of four the equivalent of a traditional Sunday roast, as well as some chicken and fish, totalling around half of present meat consumption), resulting in a reduction in stocking levels, especially for cattle
- Agriculture is more localised, producing as close as possible to the point of consumption
- Production of milk is kept as it is today, but cows are grassfed, rather than eating a grain based diet, and some eggs are also available
- Pigs are fed, as they were traditionally, using human food wastes[15], supplemented by grains
- The model allows for a doubling of woodland cover, mostly for increased firewood production
- Sufficient land is also factored in either for feeding working horses, or for the growing of enough biofuels to power a tractor
- Land is also included to grow 7kg of fibre per person for clothing
- Fruit is grown in orchards which can also double as grazing land

Figure 7 shows this model in more detail;

[15] Clearly this would need a change in the current legislation relating to feeding food wastes to livestock.



	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 land 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

Figure 7: The detailed breakdown of the Livestock Permaculture model (from Fairlie 2007)

On a national scale, this would produce an agricultural system whereby the UK "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" (ibid: 24). This paper, inspired by and based on Fairlie's work, seeks to try and explore Fairlie's model to a specific case study, to ask whether Totnes and District could feed itself, and whether it could do so from its 'foodshed', that is, the land surrounding it, using the assumptions behind the 'Livestock Permaculture' model. It would be very useful, however, to repeat the modelling being undertaken in this paper for Fairlie's other five models as well.

7. Weaving in the Foodzones

Julie Brown of Growing Communities[16], an urban organic food social enterprise in Hackney, London, has developed a model she called 'foodzones'. It sets out to try and put figures on the percentages of food that would feed London, and what distance they might travel from. It assumes an 80% national self-sufficiency, a more seasonal diet, and factors in domestic and urban food production. The result is the foodzone diagram shown in Figure 8 below;

[16] www.growingcommunities.org

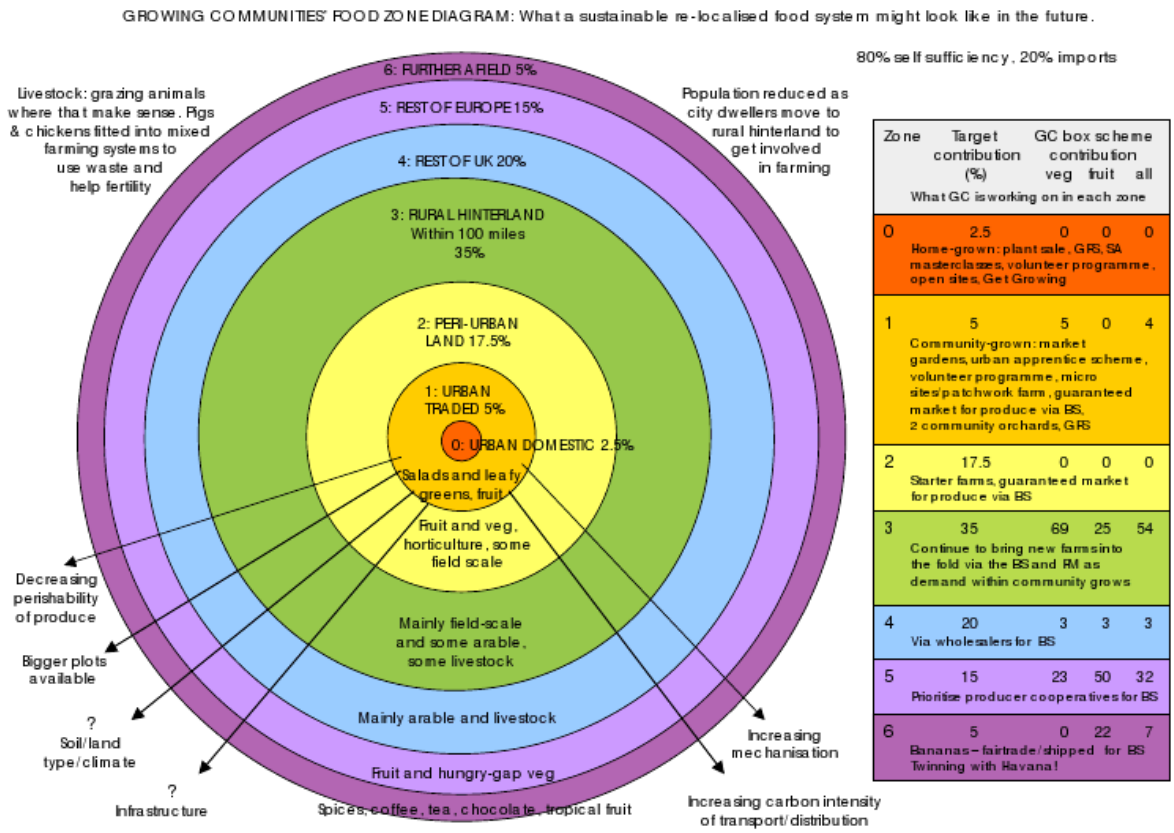


Figure 8: The Growing Communities Food Zone Diagram. Source: Brown (2009)

Brown's model offers a fascinating model for how a city might feed itself utilising the principles of the foodshed; that is, giving priority to foods grown as close as possible to the settlement. Although clearly stylised, might it be that settlements could create food systems based, at least loosely, on the stylised 'target' type model shown above?

In this research, the combined food footprint of Totnes and Dartington was calculated for their populations' main requirements, fruit and vegetables, sheep, dairy and arable. Taking the foodzone model above and applying it to the locations of Defra-defined agricultural land types in Totnes' hinterland, the foodshed analysis identifies the land types in closest proximity to the town which are best suited to different production needs.

Figures 9 and 10 break this down into more detail, looking at specific kinds of agricultural production that are possible on the land types available. Perishability and labour intensity are the drivers which give first priority to the required amount of fruit and vegetable production on the Grades 1 and 2 land in the urban area and its periphery. Next priority is Grade 1 and 2 land for arable production of cereals, sugar, hemp, flax, green manures, biofuels and fodder crops.

Defra sub-categorises its Grade 3 land into subgrades 3a and 3b, 'good' and 'moderate' quality land; the difference is potentially significant but data distinguishing the two sub-grades are not consistently available nationwide. For this model, Grade 3 and 4 land is all allocated to dairy and beef pasture. Theoretically, food zoning in the Brown model would place this activity further from the settlement, but for Totnes much of this land is in immediate proximity to the town – reflecting the wider region's strong current livestock farming economy.

Grade 5 land is best suited to sheep farming, and the nearest suitable location is some distance from Totnes, near South Brent on Dartmoor. Equally, the population here has insufficient land to grow enough grain, and the nearest place for them to grow it is close to Totnes.

This analysis has been subject to a number of data issues. Fine-scale soils data would provide a deeper insight into land suitability than the basic Defra classifications. We also lack access to comprehensive Defra data for productive urban areas or for woodlands, and the model uses additional datasets from Natural England to

identify the latter. In section 8 below we highlight the key issue of insufficient woodlands being available to provide enough wood for fuel; for the purposes of this model, woodland is regarded as an area to maintain biodiversity and offer a source of wild meat.

Also, we need to acknowledge that the agricultural land classification is of itself, fairly crude. For example, it is highly likely that there is land closer to Totnes that is well suited for sheep grazing, whereas the model suggests that Dartmoor is the closest location best suited to this type of farming. We plan in future versions of the model to be able to integrate local knowledge more fully, by using more granular datasets and also by enabling local experts to modify land parcel information. However, at this stage, the cruder method we have employed does begin to give us an insight to the food security issues not only at the local level, but just as importantly at the sub-regional, regional and indeed national level.

In section 10 below we touch on a number of additional important future research directions, including the need to understand the potential for mixed farming systems. Currently, this model takes no account of existing land ownership or actual agricultural usage, and it may also be that mixed farming systems such as agroforestry offer greater opportunities to increase overall yields, especially on Grade 3 land.

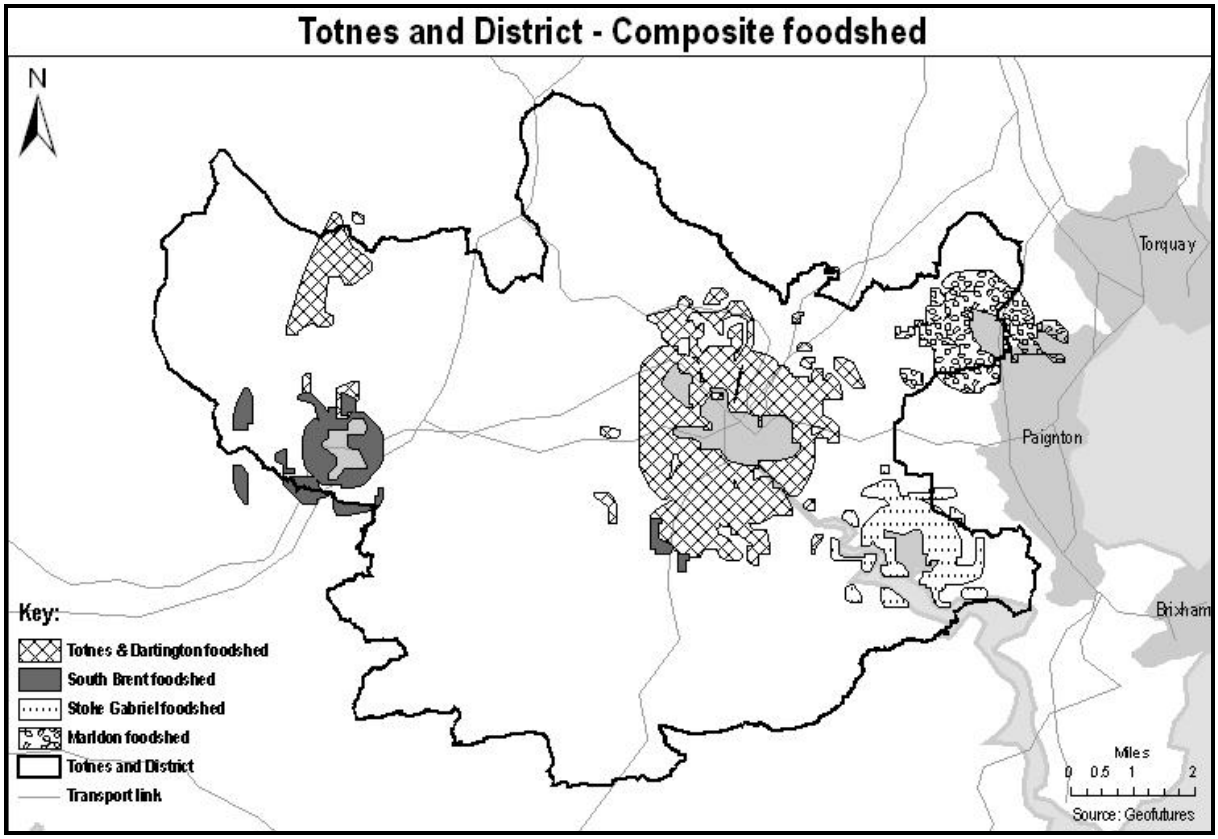


Figure 9: Composite Foodsheds for the four largest settlements in Totnes and District, showing how they do not accord with the 'foodzones' model

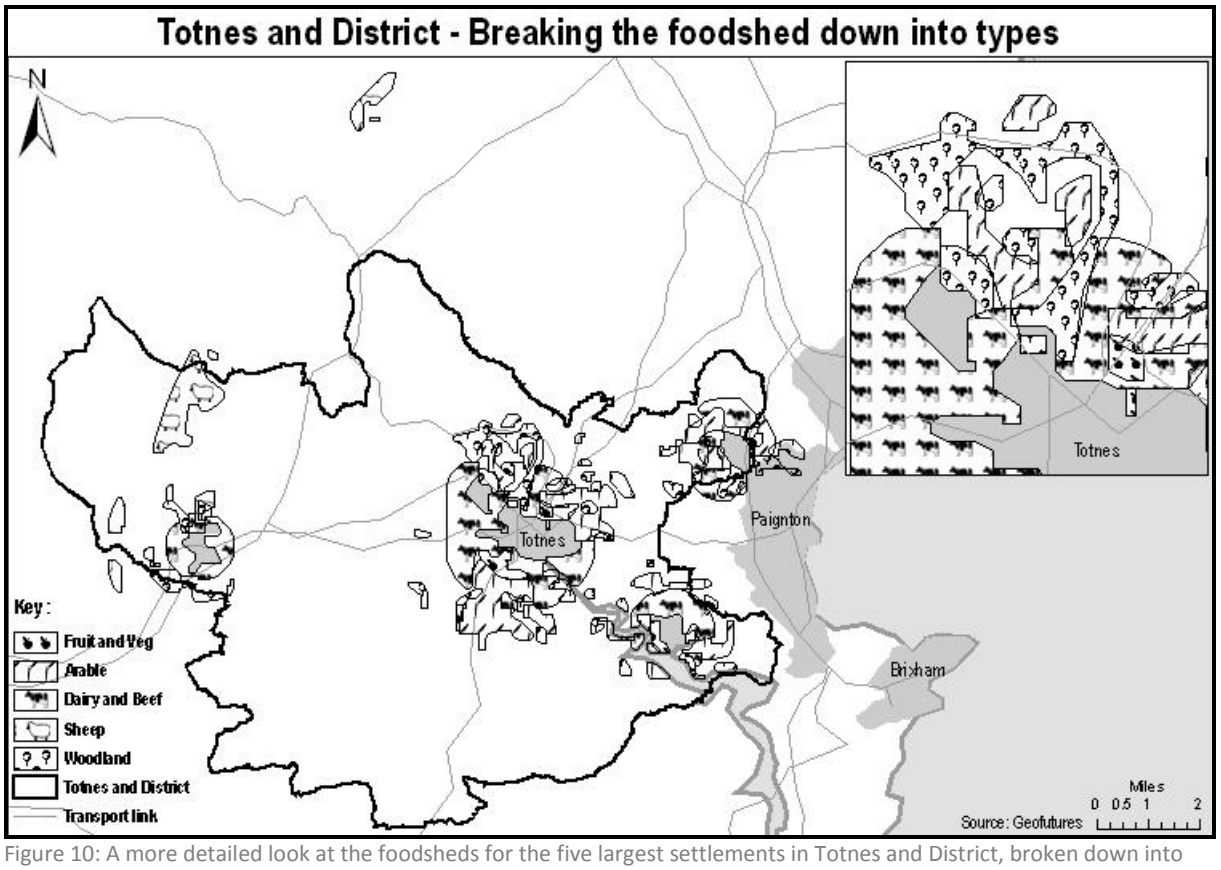


Figure 10: A more detailed look at the foodsheds for the five largest settlements in Totnes and District, broken down into agricultural production types

8. So, Could Totnes and District Feed Itself?

The foodzones we have specified in the previous section are fairly crude, and represent our efforts to calculate the amount of land required to feed Totnes and its neighbouring settlements. In this section, we explore some of the yield calculation we employed in the model.

Vegetables and Fruit

The UK presently imports 60% of its vegetables and 95% of its fruit. Feeding the area with vegetables is the easy part. Guy Watson of Riverford Farm[17] has stated[18] that 1 acre of ground[19] can produce, organically, sufficient vegetables to fill 30 vegetable boxes around the year. Given that the population of Totnes town is 8,416, a total of around 3,500 households, this suggests that around 117 acres would be required, and that for Totnes and District, with its total of 9,682 households, organic vegetables could be provided for all on around 350 acres. Oral history work conducted by Transition Town Totnes[20] suggests that the three urban market gardens that the town used to have were able to produce around 60% of the fresh vegetable requirements of the town, supplemented by that brought in to local markets from nearby farms, and also during World War Two, the nation was able to achieve yields of up to 40 tons per hectare from allotment and back garden vegetable production[21].

Given that Totnes and District contains 319 hectares of back gardens (ONS 2001), were these all to be adequately fertile, south-facing, unshadowed and accessible (that is, not covered in concrete slabs, gravel or decking), and were they to be in the hands of skilled growers reaching the kinds of yields achieved by World War Two allotment gardeners, they could theoretically produce 13,840 tons of fresh vegetables. Although all of the above would take a great deal of work, clearly supplying vegetables is not an impossibly onerous task, especially to feed a population eating more seasonal produce. Meeting demand for cereals is harder, and for

[17] Major organic grower close to Totnes. www.riverford.co.uk.
[18] Personal interview, January 2009.
[19] 40% of a hectare (www.britannica.com/EBchecked/topic/4100/acre)
[20] This will be published as part of the Totnes Energy Descent Plan.
[21] Vijoen, Andre, et al. (2005) *Continuous Productive Urban Landscapes.* Architectural Press, Burlington MA

meat, harder again. In 2004, just 4.6 hectares of land (Defra 2004) were dedicated to fruit and vegetable production, showing that at present production is way behind potential demand from a more self-reliant, localised food economy.

Cereals
In 2004, 8000 acres of land were dedicated to the production of cereals, mostly spring barley (Defra 2004). However, most of this is grown as feed for cattle eating a grain-based diet, an approach to feeding cattle which consumes a vast amount of grain. The model set out in this paper is predicated on the assumption that living within our foodshed will require our consuming significantly less meat than at present, which raises the possibility of much more grain being grown for local consumption. If the land currently dedicated to growing cereals were to instead grow for local, human consumption, it would be able to feed around 24,000 people (if they ate little else, and a lot more people if that wheat were part of a balanced diet). Cereals are hard to replace with anything else, but can easily be part of an organic rotation.

In terms of wheat grown for bread production, the climate of Devon doesn't make it the ideal place, increasingly the susceptibility to moulds and fungal diseases. Also, bread makers tend to prefer wheat with a gluten level above 12, whereas locally grown wheat struggles to get above 8. More research into other grains, such as spelt, is needed.

Meat
As set out above, this scenario requires the consumption of much less meat than is presently consumed. In particular, it requires a move away from grain-fed cattle, moving towards grassfed animals, especially using systems such as foggage[22] which require fewer inputs. It also needs more consumption of chickens and pigs, and their being used as part of integrated, mixed farming systems.

A significant proportion of the protein required, presently supplied by meat, could be provided instead by nut production. The Agroforestry Research Trust, based in Dartington, has been researching nut varieties and their potential productivity in a Devon context, and their research suggests that hybrid walnut and sweet chestnut varieties could produce, after 15 years, 1 ton of walnuts per acre, roughly equivalent to the organic production of wheat. This agroforestry approach carries the advantage that it can be worked in around current farming without requiring an overnight change in conventional farming practices, although it is an element that requires a longer lead-in time than other approaches. One ton of walnuts is estimated to yield 60% of its weight in edible oil (Crawford 1996).

Alcohol
There are no figures for the amount of land required to provide alcoholic drinks for Totnes and its surroundings, but Sharpham vineyard has calculated that its current level of production, were it to be focused purely on local markets, would provide 1 bottle of Sharpham wine per month for each of the 22,000 people within Totnes and District. Traditionally, the area drank more cider and beer. Many of the cider orchards have now been lost, and even when they existed, the area was still a net importer of apples (from Brittany) for cider production. Beer should be easier; 1 ton of hops and 100 tons of barley produces around 800,000 pints of beer, so meeting the area's beer requirements should be easier, although at present little or no hops are grown in the area.

Dairy (milk and cheese)
Fairlie's Livestock Permaculture model (see above) suggests that meeting a national, per capita demand for 568g per person of milk (slightly over a pint) per day, which is sufficient for milk and dairy products, requires 2,825,000ha of arable land and 1,765,000ha of permanent pasture nationally. This figure is for grass-fed, organic cows, which includes calves and heifers, so there would also be the potential to produce some beef from this. Scaled to a Totnes and District population of 23,914, this requires 1072ha of arable land and 669ha of permanent pasture, making a total of 1741ha of land required for dairy production, which is about 1/13th ha. per person. Devon has, of course, long been a milk-exporting part of the country.

[22] Little is written about the foggage system. Developed at Fordhall Farm in Shropshire by the late Arthur Hollins, it is a system of permanent grass-based livestock farming, using a broad diversity of grass species. See Whitefield, P. (2004) *The Earth Care Manual: A Permaculture Handbook for Britain and Other Temperate Countries.* Permanent Publications.

Little remains of the infrastructure of local dairy processing that was once a feature of life in the area. Gone is most of the network of local creameries, local bottling plants and the idea that milk produced locally is consumed locally. Exceptions are a biodynamic farm near Totnes which sells unpasteurised milk directly into the town, and Riverford Organic Farm, who produce a range of organic dairy produce, sold within Totnes and District but also further afield. Riverford's dairy has a throughput of 2,287,680 pints of milk per year, which equates to 96 pints per person per year, around one quarter of the area's demand. The recent closure of the Dairy Crest milk processing plant in Totnes has led to a further demise of the capacity of the area to supply its own dairy needs. One interesting observation[23] from Riverford is that its processing of the milk into skimmed and non-skimmed milks, yoghurt, cream and butter creates far more jobs than the actual milk production, emphasising the benefits to the local economy of more localised milk processing. Riverford state that their milk processing facility is currently only working at half its potential capacity[24], so were more organic milk to be produced, they would be able to supply more than half of Totnes and District's needs.

Timber for fuel

At present, only 585 hectares are dedicated to woodland in the Totnes and District area (Defra 2004). The woodland owned by the Dartington Hall Trust, if sustainably managed, is estimated to produce insufficient firewood even for the Dartington Estate's proposed woodchip boilers, and the same is the case for the Sharpham Estate. The Forestry Commission (1988) estimate that yields from well designed coppice can range from 2 tons per hectare for most varieties (i.e. oak, alder, sweet chestnut) and up to 6 for poplar and willow. We have therefore taken an average of 3 tons per hectare for this paper. We do note, however, the probability that the impacts of climate change may well include increasing risks of pest or disease outbreaks and of fire, although for some species, and for plantings that take this into consideration, yields may turn out to be higher.

The average house, retrofitted and with an efficient woodstove and solar thermal panels, using wood for central heating and backed up by solar panels for hot water, would require around 7 tons of dried timber per year. Totnes and District contains 10,352 households, which at 7 tons of dried firewood per household, would need 72,464 tons of firewood. At an output of 3 tons of firewood per hectare, meeting this demand would require 24,154 hectares of well managed coppice woods, of which 22,858 would need to be newly planted. Unfortunately, Totnes and District only contains 23,443 hectares of land in total. There is clearly a major role for energy conservation, other technologies such as heat pumps, and also for anaerobic digestion (which could also play a role in cycling fertility). The answer to the question 'Can Totnes Heat Itself?' appears to be a resounding 'no'. We have also been unable to establish figures for the potential timber output from the management of hedgerows.

9. Maintaining fertility

Currently, most conventional agriculture depends on imported fertility, usually nitrogen fertilisers made from natural gas. This is unsustainable in many ways, most notably in the precarious nature and affordability of the UK's natural gas supplies (see Figure 11, below).

Clearly the provision of fertility is the principal limiting factor in UK agriculture. Well-designed farming systems are able to provide for their own fertility, through a combination of good waste management and return of fertility to the soil, as well as well-managed rotations of pasture and arable. Land under pasture will accumulate nitrogen, potassium and potash, and will deplete them if used year on year. The balance, in the Totnes and District land base, of arable and temporary grassland is ideal for the area to be able to balance its fertility without the need for external inputs. This can be speeded up with the addition of clover to the temporary grass leys. The area at the moment has about 5 hectares of grass for every 2-3 hectares of arable land, which is the ideal proportion.

[23] From personal communication with John Watson, founder of Riverford Farm, 24th June 2009.
[24] Ibid.

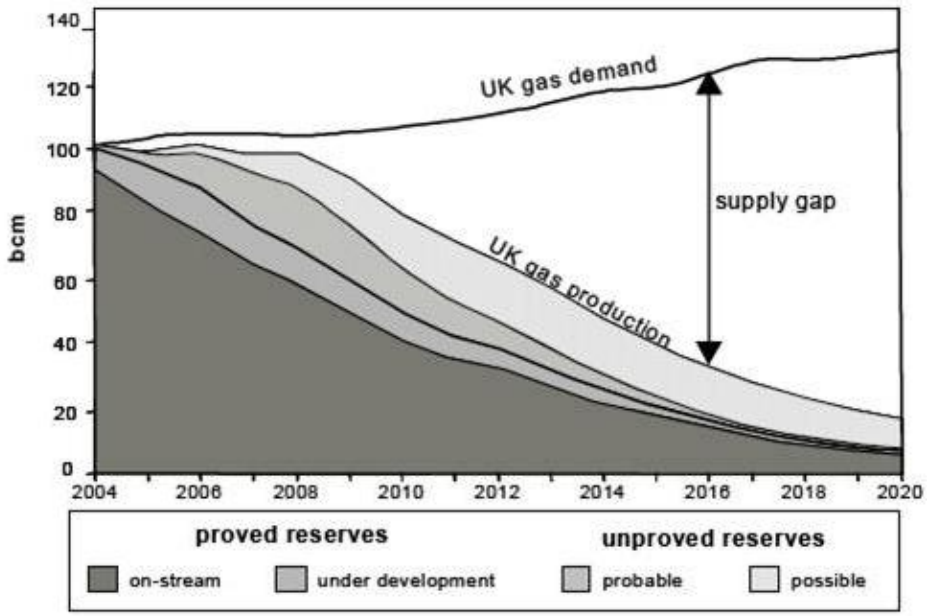


Figure 11: The forecasts for UK natural gas production to 2020, showing a precipitous decline over the next seven years. Source: Parliamentary Office of Science and Technology (2004)

The 'bringing home' of food production will also require a reduced dependency on imported fertility. This will require a fresh look at how the area treats its human waste, as human waste contains the nitrogen and phosphorous equivalent to that which agriculture requires to produce its food. Systems for safely and hygienically collecting and utilising human urine as a replacement for nitrogen fertilisers exist in other European countries, and systems for the safe composting of human waste have also been developed[25].

10. Other questions and challenges

Clearly, the move from Totnes and District being merely one outlet of a vast and profoundly unsustainable globalised food system towards being a more self-reliant and resilient local 'foodshed' is a vast undertaking. Nonetheless, given the impending peak in world oil production and the need to reduce emissions from agriculture by 80% over the next 40 years, this is a shift which is inevitable, and the sooner it is embarked upon, the greater chance it has of success[26]. This research is in its early stages, but it may be useful at this point to identify some of the challenges and issues that have emerged thus far;

- An unknown percentage of the land that would be needed for this kind of approach is low-lying and at risk from flooding and other climatic and meteorological impacts that will arise from climate change. Furthermore, the Livestock Permaculture model itself is based on our understanding of our current temperate agricultures system; how applicable this will be in a couple of decades time is moot. More research is needed on this and on the amount of land it might remove from food production, or the changes in land use it might necessitate.
- Many of the datasets required to do this research more fully, and on a national scale, are not in the public arena and are hugely expensive to obtain. These include one which allows a calculation to be made of the exact amount of land currently utilised by back gardens in any given settlement. Accessing the appropriate data sets will allow this work to be much more thorough.
- No exact data are included here with regards to the amount of fish that could be included in such an approach. The proximity of Totnes and District to fishing ports such as Brixham offers the possibility of significant input of protein, although at the moment most of that fish goes to markets elsewhere.

[25] For one example of this from Sweden, see Schonning, C. (2001) *Urine Diversion: hygienic risks and microbial guidelines.* www.who.int/water_sanitation_health/wastewater/urineguidelines.pdf.

[26] A point made most cogently in Hirsch, R.L.Bezdek, R, Wendling, R. (2005) *Peaking of World Oil Production: impacts, mitigatation and risk management.* US Department of Energy. Retrieved from www.netl.doe.gov/publications/others/pdf/Oil_Peaking_NETL.pdf

- This paper has explored the supply side of such an approach. The equally difficult aspect is that of creating the demand for locally grown produce, in the age of supermarkets and convenience foods. Although some models exist[27], the generation of sufficient demand to support such a transition presents major challenges in the current economic paradigm.
- A calculation is needed for the potential generation of energy from anaerobic digestion, utilising slurry and other farm wastes, as well as waste food, and their ability to provide space heating, thereby reducing the demand for firewood, shown above to be potentially insatiable if viewed as the only source of space heating.
- Much of the land in the area being looked at here is hilly, unsuited for grain production. Exploration of new ways of using such land productively will be a key part of this conversation.
- Can this land use model be expanded to include other essentials like building materials, and medicines?
- The thorny issue of population needs to be explored, both the question of whether there are too many people in the area, and also in terms of the fact that Devon County Council states that in 2009, one in five households are pensioners living alone. Also of concern is the current average age of the Devon farmer, raising the important question of who will actually do the work required by this approach to feeding the area.
- Another challenge revolves around issues of nature conservation. Clearly the expansion of food production requires us to reassess current concepts of nature conservation, in which food production and habitat protection are often viewed as being mutually exclusive (as indeed with intensive agriculture they often are).
- Another challenge lies with the planning system, and the tensions that will arise as more people need to live in agricultural areas.
- The area of reskilling is also vital. The huge majority of people no longer have any experience or knowledge of food growing on any kind of scale, and farming as a profession has also become deskilled over the last 40 years. The training question is key; who is to be trained, where, and what will they be taught?
- One of the key challenges the authors of this paper have faced has been the data available for yields from different land uses. Clearly data exists for yields from dairy and arable production, but little exists for more mixed, integrated approaches such as agroforestry. More data on this is urgently needed.

11. Getting from Here to There: the nuts and bolts of the Transition

It is, of course, not possible to implement such a change overnight. It would require an unprecedented collaboration and shared sense of urgency and purpose, akin to that seen in 1939, when the amount of land under cultivation increased from 12.9 million hectares in 1939 to 19.8 million by the end of the war. Food production during that period had risen 91%, and the UK was able to feed itself for approximately 160 days a year, rather than the 120 days it had been in 1939 (Gardiner 2004). There was also, of course, the famous 'Dig For Victory' campaign, which led to a significant proportion of the nation's diet coming from back gardens and allotments. One of the challenges faced today is how to design the business models required to bring this about in such a way to make them financially viable in the current economic situation, which is very different from that in which they will need to function in 20 years' time. Models which offer potential for being integrated into existing farming enterprises will be vital.

Part of making such an approach possible will be the implementation of new models for getting food to people. These will include (but not be limited to) Community Supported Agriculture, consumer/farmer co-ops, farmers' markets, local procurement, local processing, local investment mechanisms and many more. There will also need to be a huge programme of reskilling, given the small number of people with broadscale food growing skills. Engagement will need to be deep and cross-sectoral. The Transition movement is one of many that are looking at the practicalities of rebuilding local economies, and this paper is an indication of the scale of its thinking. How the various models and approaches might fit together is a key part of the thinking that

[27] For one summary of some of the potential models, see Hopkins, R. (2000) The Food Producing Neighbourhood. In Barton, H. (ed) (2000) *Sustainable Communities: the potential for eco neighbourhoods*. Earthscan Books (2000)

Transition initiatives do, and this paper identifies the need for a national-scale version of the research that underpins this paper, as part of a food plan for the UK.

Conclusions

This paper has offered a very rough, broad-brush attempt at addressing the question "Can Totnes and District feed itself?" Utilising GIS mapping and the datasets that are currently accessible, it has explored the current land classes and how farmland is presently used, and then, using Simon Fairlie's 'Livestock Permaculture' model, has tried to assess whether or not Totnes and District could actually feed itself. Even if we were to assume roughly stable climate conditions, the answer is that yes, it could, but only if:

- it lived in isolation from its neighbouring major conurbations of Plymouth and Torbay; when these settlements are factored in, it becomes far more difficult;
- Far far more people lived on, and worked, the land; and
- We ate a very different diet to the one we consume today.

Those current eating habits, current levels of meat consumption, as well as the long supply chain, just-in-time distribution models on which the food system is based, are all key factors in the inability of the area to meet its food needs. The approach explored here has looked at an alternative to the current paradigm, arguing that interests of sustainability, resilience, health and nutrition and long-term economic stability are best served by a move, through a well designed and integrated approach, towards the area meeting its food needs as close to home as is practicably possible.

It raises the question as to whether, in times of increasing unemployment and economic contraction, the 'outsourcing' of food to whoever can produce it cheapest in the world is an economic own goal. It could be that the relocalisation of the food economy would have huge benefits to the local economy, creating a wide range of jobs. Although the mechanisms and structures needed to make this possible are, in some cases, still at a very early stage of evolution, this paper contends that they are possible and indeed are urgently needed.

This paper has taken an approach which assumes forms of agricultural land use are separate and un-integrated, so that dairy farming happens in one place, forestry in another, and fruit growing some else again. One of the areas for future research that emerges from this paper is the need for more hard data about integrated systems, well designed forms of land use which integrate the production of fuel, medicine, freshwater fish, fruit, vegetables, herbs and so on. One such a model exists in agroforestry, and one of the primary research centres into this, the Agroforestry Research Trust[28] is based just outside Totnes. A more widespread adoption of this model could prove a key element in the UK's ability not only to feed itself, but to fuel, warm and heal itself too. Ultimately it could turn out that Totnes and District can feed itself, and could be healthier, wealthier and wiser for having done so.

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[28] www.agroforestry.co.uk

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