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CCF Food-Growing Projects Evaluation

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Key points

Food-growing in allotments could, in a best case scenario, offset up to 5.6% of the GHG emissions[i] produced each year by commercial agriculture. It has potential to reduce emissions further through positive spill-over effects in: a) related areas such as composting, recycling, tree planting; and b) non-related areas such as household energy reduction, recycling, and transport practices.

- GHG reductions of up to 5.6% from food-growing projects consist of:
    - Reduced transportation related to food (2.3% of total GHG emissions; 50% from importing, 38% from road distribution, 13% car shopping)
    - Less post-harvest waste (2% of total GHG emissions)
    - Less packaging (1.3% of total GHG emissions)
    - Potential of greater vegetable content in diet, with consequent less reliance on meat
- School projects differ from non-school projects in the following ways:
    - School projects and activities have to be tailored to age group and might be transferable to other groups with similar requirements
    - School networks can enable projects to spread and they can generate visibility within local communities
    - School projects potentially instil green behaviour that might persist through later life
    - School projects have the potential to influence others in the community (families) through single contacts (children)
- Participatory approaches and techniques to encourage spill-over (e.g. workshops, training and courses) are likely to have greater impact than non-participatory ones (e.g. mailshots)
- Food-growing can potentially fail to lower GHG emissions if best practice composting, soil management, and diversification systems are not adopted

Recommendations for the panel

Food-growing projects can best achieve carbon emissions savings through spill-over by:

- engaging participants through participatory workshops and hands-on activities
- actively involving participants in all stages of the project, including development and delivery
- maintaining good communication with members of the community and local groups of interest
- including children/schools
- using existing networks (such as clubs)

The evidence suggests that carbon emission savings are likely to be greatest where project proposals:

- indicate an awareness of the need to gather CO_2 related data throughout the life of the project
- incorporate education/training (e.g. talks, workshops by qualified people/agencies) in the delivery of the project
- have good record keeping procedures (e.g. yield, attendees, volunteers, participants)
- highlight to volunteers and others associated ways in which carbon reductions (spill-over) can be achieved, and demonstrate practical application
- have good communication with the local community
- are able to network with existing groups and projects
- follow best practice for food-growing (e.g. optimised fertilisation of crops, rotation, multiple crops), composting[ii] and waste management

1. Introduction

Food-growing has a long history in the UK during which time it has contributed to different social objectives, including alleviating the distressed poor (see Crouch and Ward, 1997) and contributing to the WW2 effort through the 'dig for victory' campaign. More recently, food-growing has been seen as an important way to contribute to GHG savings by reducing food miles and encouraging greater consumption of local produce. In addition, food-growing has the potential to have positive social effects, such as greater community cohesion, and increased human health and well-being (Parr, 2007).

In this context food-growing can be seen as 'catalyst behaviour' that "may cause people to start another, or many more, pro-environmental behaviours" (Austin, Cox, Barnett and Thomas, 2011). These new behaviours, or spill-over effects, refer to the indirect, sometimes unintended, consequences or side effects of some intervention, event or occurrence. For the purposes of this report spill-over effects are defined as 'additional emissions-reducing behaviour change in participants and the wider community'. In a food-growing context positive spill-over is additional emissions-reducing behaviour not related to food growing, such as reducing household energy. Negative spill-over, also known as the rebound effect (see Herring and Sorrell, 2009), may also occur.

2. What does good practice looks like in food-growing projects in terms of carbon emissions reductions?

In a best case scenario where 'best practice' was followed across all UK allotments, food-growing in allotments and gardens could have a maximum direct carbon abatement of 5.6% of the GHG emissions produced each year by agriculture. These theoretical maximum emissions savings arise from: reduced food transportation (2.3% of total GHG emissions from agriculture; 50% of this from importing, 38% from road distribution and 13% from car shopping;), reduced post-harvest waste (2% of total GHG emissions from agriculture) and reduced packaging (1.3% of total GHG emissions from agriculture). Assuming best food-growing practice, it is reasonable to expect a yield of 3kg per m^2 for mixed growing of fruit and vegetables to as much as 10kg m^2 for high-yielding fruit trees from allotments/raised beds. On this basis, one kg of produce grown in an allotment could have up to 5.6% lower GHG emissions than one kg produced in the agricultural sector - however all of this saving is likely to be associated with transportation, post-harvest waste and packaging, not production per se.

Food-growing has the potential to reduce emissions further through spill-over effects. An unquantifiable level of spill-over can be expected from food growing projects: a) related areas such as composting, recycling, tree planting and b) unrelated areas such as household energy reduction, recycling, and transport behaviours.

In relation to school projects there are a number of factors that may potentially contribute to further, but unquantifiable, spill-over: projects and activities that are tailored to specific age groups could make information more accessible (and might be transferable to other groups with similar requirements); school networks can enable projects to spread and gain visibility within local communities and further afield; they have the potential to instil green behaviours and values at an early age which might persist through later life; and they have the potential to influence behaviour more widely (families) through single contacts (children).

3. What does best practice look like?

Wider behaviour change

The evidence suggests (see Annex 1 for project selection process) that successful food-growing projects make use of a range of approaches and techniques to engage participants, and that these have potential to generate spill-over effects. Techniques that engage participants in participatory activities (e.g. workshops, training, open days and courses) are likely to generate greater spill-over than non-participatory techniques (e.g. mailshots), see Project selection process

For the evidence review a full list of the CCF projects which list food-growing as their main purpose was reviewed. In total there were 154 projects in the CCF database but only 125 were eligible for screening (as 29 of them did not have completed reports). The 125 available projects were reviewed based on their short summary by each of the researchers, independently, and scored using the following criteria:

1 - INCLUDE: food growing seems central and explicitly considers 'children/schools' involvement in the project

.5 - INCLUDE: food growing seems central but children do not

0 - EXCLUDE: food growing does not seem to be central

In the next step the projects were ranked by the total sum of researchers' scores. A maximum score of 3 was taken as a total agreement on food growing central projects that consider children (N=13); a minimum score of 0 was understood as a total agreement on excluding a project as it does not seem food growing central (N=19) and a mean score of 2 was assumed to be high agreement on food growing centrality but required consideration on the centrality of children focus (N=37) for example some projects are described as happening in a school but they do not necessarily include children throughout the project. We excluded other totalled scores as this meant high disagreement between researchers. We selected every second project with a score 3 and every fifth project with score 2. In total 12 projects were reviewed in detail, 6 projects that focus on children and 6 projects that do not focus on children.

Table 1 in the Annex.

Methods for maximising 'spill-over' behaviour change effects rely on: engaging participants through participatory workshops (hands-on activities); involving the participants throughout the life of the project; maintaining good communication with the community and local interest groups; including children/schools in the projects and using existing networks (such as clubs).

Inputs to growing

Best practice suggests that care is given to identifying the optimal rate of fertilisation for crops. The optimal addition of fertiliser for yield and reduced GHG emissions are not necessarily the same: high value crops (horticultural crops) often have a wide gap between optimal yield and GHG production.

In an ideal scenario, land is corrected for mineral deficiencies, toxicities and pH followed by Best Practice Low Emissions (BPLE) composting by taking off residues and composting them. This includes replacing mineral fertilisers with compost. However, it is important to highlight that external inputs (NPK, manure, council compost) will not be able to be eliminated completely. Compost should only be recommended if it is produced by best practice (Lundy and Peters, 2005). This requires centralisation and/or education, as anaerobic production and timing of compost addition can greatly affect methane production (

Annex 2:
Figure 1 in Annex 2). For example, removing debris and straw from site and compost material will reduce net N_2O and methane emissions.

Best practice would follow a highly productive, diverse (e.g. rotation, multiple crops) system that uses resources as efficiently as possible. For example, GHG emissions can be manipulated through the crop you choose. Tree crops are least emitting (by locking carbon up in biomass and requiring little input , better still if these can provide products whether fruit, nuts or fuel). This is followed by vegetables such as cabbage, potatoes, tomatoes, beans, and finally other root crops. To minimise GHG emissions from allotment grown fruit and vegetables, a recommendation would be to grow leafy vegetables, potatoes and perennial fruit trees with NPK, animal manure or BPLE compost as a fertiliser source. Moreover, avoiding waterlogging will reduce the opportunity for anaerobic conditions in the soil and reduce methane emission.

More research is needed to identify optimal rates for fertilisation of crops and use of external inputs for all species and varieties, therefore it is not possible to provide a threshold beyond which inputs cancel out carbon savings from produce displaced. As a rule of thumb for the purposes of carbon abatement, growers should fertilise to optimise GHG emission reduction rather than yield. Research into the difference between these two optima for different species needs to be done. But in particular circumstances, best practice may be to keep reducing your N inputs year on year until the point when appreciable yield is lost. The following year you should then go back to the previous year's input and then maintain it. This way each grower defines the threshold they can achieve to minimise fertiliser inputs and maximise yield.

4. Recommendations for carbon best practice guidelines for food growing projects

Promoting allotments and community gardens to reduce GHG emissions is beneficial. Reductions may be achieved through growing food in allotments as well as through associated behavioural changes. Such behaviour changes are difficult, if not impossible, to quantify in terms of their contribution to GHG reduction. Behavioural changes are enhanced through structured engagement activities (workshops, training and open days), achieving visibility (e.g. through being part of a wider network of activists looking to reduce carbon emissions) and providing practical advice and incentives to adopt changes (such as reducing car parking spaces at certain sites or encouraging re-use of water bottles). In addition, there is anecdotal evidence that especially community garden projects encourage social interaction which enhances community cohesion and may lead to new behavioural norms, although this is a long-term process and cannot be shown from the CCF projects funded so far. Behavioural spill-over effects are not simply the result of cause and effect, but occur due to a combination of different factors, of which food-growing may only be one of the catalysts.

In relation to achieving greatest carbon savings from food growing activities, attention needs to be paid to composting methods, which can be extremely variable in their production of GHG emissions and will probably be the greatest variable in the allotment/home production management regime. The greater the opportunity for anaerobic decay, the greater the methane and nitrous oxide production. Composting systems must be designed to limit the amount of GHG emissions otherwise compost cannot be recommended for allotment or home/community gardens (see previous section on best practice).

Assessing the GHG emissions associated with polytunnels and polycrubs is complicated. GHG emissions per area in polytunnels and polycrubs will be greater due to increased temperature. But as the yield will be greater, GHG emissions per tonne of produce are likely to be reduced. Polytunnels and polycrubs extend the season, meaning greater production per year and resource. They also allow the growing of more exotic species, reducing the emissions associated with importing these. Polycrubs may be better than polytunnels as they are stronger, need replacing less often and use recycled materials, therefore reducing the GHG emissions in producing them. Further research is required in order to establish which is more sustainable over its life cycle.

Raised beds are likely to be beneficial in reducing GHG emissions. Such systems are likely to be better drained than flat soils, therefore less anaerobic production of methane and nitrous oxide. Soils in raised beds will be tend to be imported and better quality, thus better drained and less reliant on the addition of fertiliser. However, in dry years raised beds may need irrigation with all the GHG emissions this entails. If rain water can be harvested from a larger area then this may minimise the impact of irrigating.

We provide the following comments in relation to popular techniques, management practices and inputs to growing in the reviewed CCF food-growing projects:

- Greenway is a system that relies on the production of compost and biohumus. The compost is produced using a Greenway HotBox and the biohumus is produced using vermiculture (worms). There is no information on the GHG emissions from these systems so it is not clear whether these are low-emission composting systems or not. If they are not then this system should not be recommended.

- Permaculture and organic systems (which rely on the addition of non-mineral fertilizers and fertility that relies on manure, green manure, composts and rock minerals) will not necessarily have a positive impact on GHG emissions compared to intensive agriculture. GHG reductions will depend upon whether best practice is followed in terms of optimal fertilisation of crops, composting and waste management.
- No-dig systems have shown various abilities to sequester carbon, increasing carbon content in some soils and losing carbon in others. The general view is that no-till systems reduce GHG emissions both from soil and from the need to use machinery to till the land.

A caveat to these particular common techniques is that there are also GHG emissions associated with producing and transporting polytunnels and polycrubs. New polythene has to be added regularly to maintain efficient growth production, which leads to emissions. There will also be GHG emissions associated with building raised beds and importing soil.

With respect to carbon accounting, the data provided in the selected CCF food-growing projects are not adequate to make a scientific appraisal of the CO_2 savings. It is necessary to express GHG emissions in terms of yield rather than land area (size of the plot). Whilst the assumptions of the Low Carbon Road Map are used in some projects it is questionable whether these are adequate in every case.

5. Issues encountered/caveats to the report

The level of project reporting is not consistent. As such, spill-over effects from food-growing projects are difficult to quantify. Food-growing can be a catalyst for further low-carbon/energy reducing behaviours but the causality of the relationship is not straightforward, and behaviour change may be due to engagement techniques and factors other than food-growing which are not accounted for in the reports.

It is difficult to evaluate negative spill-over effects. Further research is needed to identify the extent to which food-growing may increase GHG emissions due to, for example: the GHG associated with building and maintaining allotments/gardens; badly composted waste; greater food preparation; greater temperature controlled conditions for food storage and greater calorific intake required to sustain increased levels of human labour.

6. Summary

Food-growing projects have the potential to reduce GHG emissions from food-growing activities and through triggering associated behaviour change. Food-growing in a best case scenario can offset up to 5.6% of the GHG emissions produced each year by commercial agriculture. An unquantifiable level of spill-over in related behaviour change can be expected from food growing projects in a) related areas such as composting, recycling, tree planting and b) non-related areas such as household energy reduction, adoption of pro-environmental recycling and transport practices.

The evidence suggests that successful food-growing projects make use of a range of approaches and techniques in order to engage participants. Techniques which engage participants in participatory activities (e.g. workshops, training, open days and courses) are likely to generate greater spill-over behaviour than non-participatory techniques (e.g. mailshots). Schools projects have potential to generate spill-over through using existing education networks, instilling green behaviour & values at an early age, and reaching families and friends through the child contact (s).

Best practice to reduce GHG emissions from food growing suggests that care is given to identifying the optimal rate of fertilisation for crops and that a highly productive, diverse (e.g. rotation, multiple crops) system is followed, which uses resources and deals with waste as efficiently as possible. More research is needed to identify optimal rates for fertilisation of crops and use of external inputs for all species and varieties, therefore it is not possible to provide a threshold beyond which inputs cancel out carbon savings from produce displaced.

ANNEXES

Annex 1: Project selection process

For the evidence review a full list of the CCF projects which list food-growing as their main purpose was reviewed. In total there were 154 projects in the CCF database but only 125 were eligible for screening (as 29 of them did not have completed reports). The 125 available projects were reviewed based on their short summary by each of the researchers, independently, and scored using the following criteria:

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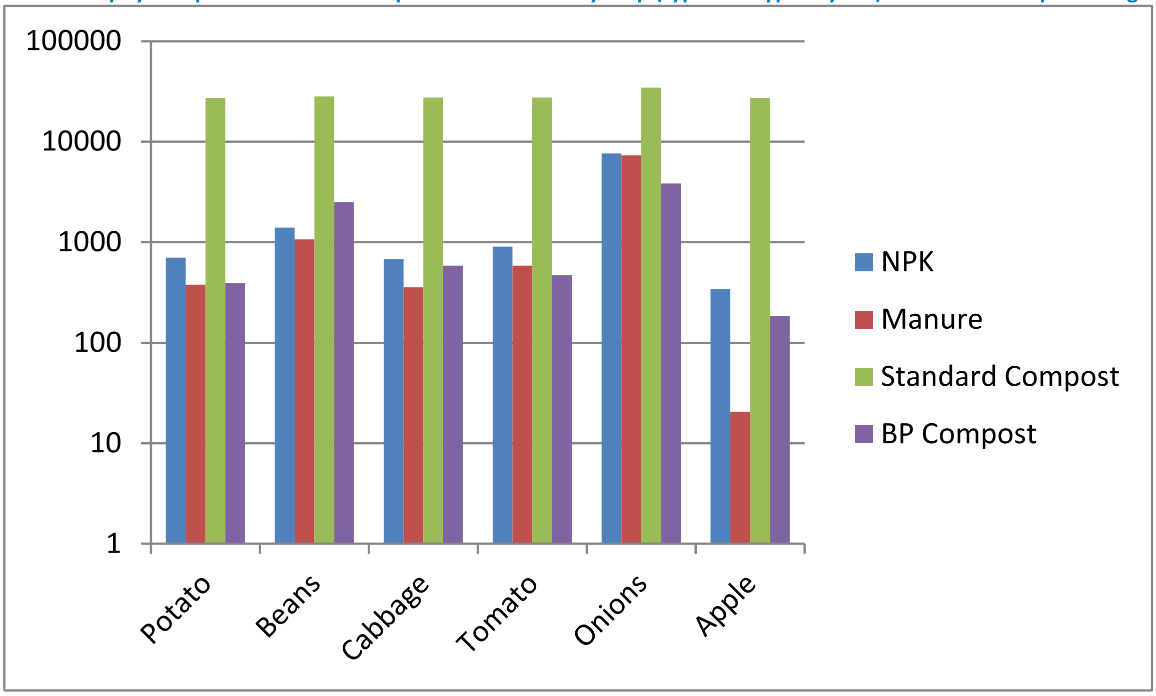
Table 1. Examples of participatory and non-participatory approaches and techniques identified in the reviewed CCF food-growing projects

Participatory approaches and techniques *(Hands-on)*	Non-participatory ones
• Workshops: shed and cabin building, fencing, planting (trees, herbs, plants), composting, waste disposal (e.g. food, green waste), food preparation, edible plants identification (plants, fruits, herbs), growing (pruning, scything, potting, caring for produce, improving soil quality), gardening, craft making (with goods that can be reused or recycled), tool using and care, recycling, wood work, vegetable carving, willow weaving, bee keeping, chicken keeping, wormeries, watering and rainwater collection • training • courses • grown your own day • taster afternoons • open gardens • surplus plant and seeds give away events • growing competitions • seed swapping	• cookery demonstrations • information sessions (meetings) as well as provision of information through media campaigns (e.g. leaflets, newspapers, radio), for example healthy eating, energy saving, recycling, etc.

Annex 2:

Figure 1. Emissions in kg GHG (CO_2-equivalents) per hectare per year from different vegetable production systems with different fertiliser sources balanced for N. Data produced using Cool Farm Tool ghg emissions calculator (http://www.coolfarmtool.org/CoolFarmTool). All other biophysical parameters were kept constant and only crop (type and typical yield) and fertiliser input changed.



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[i] The reported GHG emission reductions are based on an average estimation of total UK allotments production (225 000 tons of produce, 300 000 allotments at 250 m^2 each with potential of 30 tonnes per hectare) when compared against the 7 500 000 tonnes of vegetables produced by commercial agriculture each year.

[ii] Identify optimal rate of fertilisation for crop (i.e. RB209). Once land is corrected for mineral deficiencies, toxicities and pH then build up best practice low emissions (BPLE) compost by taking off residues and composting them. Poor production of compost will lead to extremely high emissions from growers' land. Gradually replace mineral fertilisers with compost. External inputs (NPK, manure, council compost) will not be able to be eliminated completely as some minerals are going off in harvested product (for example Government promotion of grow your own could be through offering soil testing as best practice recommendation from a soil mineral nutrition and greenhouse gas abatement perspective).

[iii] If the projects in turn included schools or children activities the next project 'down' was selected instead.