System Report: Agroforestry for Organic Egg Production in the Netherlands

Project name	AGFORWARD (613520)
Work-package	5: Agroforestry for Livestock farmers
Specific group	Agroforestry for organic egg production in The Netherlands
Deliverable	Contribution to Deliverable 5.13 (5.1): Detailed system description of a case study system
Date of report	12 November 2015
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Contents

AGFORWARD (Grant Agreement N° 613520) is co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD. The views and opinions expressed in this report are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission.

1 Context

The AGFORWARD research project (January 2014-December 2017), funded by the European Commission, is promoting agroforestry practices in Europe that will advance sustainable rural development. The project has four objectives:

1. to understand the context and extent of agroforestry in Europe,
2. to identify, develop and field-test innovations (through participatory research) to improve the benefits and viability of agroforestry systems in Europe,
3. to evaluate innovative agroforestry designs and practices at a field-, farm- and landscape scale, and
4. to promote the wider adoption of appropriate agroforestry systems in Europe through policy development and dissemination.

This report contributes to Objective 2, Deliverable 5.13: "Detailed system description of a case study system". The detailed system description includes the key inputs, flows, and outputs of the key ecosystem services of the studied system. It covers the agroecology of the site (climate, soil), the components (tree species, crop system, livestock, management system) and key ecosystem services (provisioning, regulating and cultural) and the associated economic values. The data included in this report will also inform the modelling activities which help to address Objective 3.

2 Background

The initial stakeholder report (Bestman 2014) and the research and development protocol (Bestman 2015) provide background information on agroforestry for organic egg production in the Netherlands.

A free-range area contributes to the welfare of laying hens. Studies that have looked at the relation between the use of a free-range area and the degree of feather pecking damage have found that if more hens from a flock use the free range area, then significantly less feather pecking damage is seen (Bestman and Wagenaar, 2003; Green et al. 2000; Mahboub et al. 2004; Nicol et al. 2003; Lambton et al. 2010; Bestman et al. in preparation). A higher percentage of hens using the free range area can be achieved by providing shelter (Zeltner and Hirt 2003; Bestman and Wagenaar 2003). This can be artificial structures or natural for example with trees, bushes or other vegetation. Moreover, if there is no such shelter, then especially in flocks of more than 1,000 hens, only a small minority of the hens will go outside. In the Netherlands the mean size of an organic egg farm is 11,000 hens with 4.4 ha free range area. A mean conventional free-range farm is 24,000 hens with 9.6 ha free range area (PPE 2013). Maximum group sizes are 3.000 and 6.000 respectively for organic and conventional hens. Organic groups must be separated both inside the building and in the free-range area. Conventional free-range groups only must be separated inside the building. Providing cover on such large surfaces is expensive. Therefore farmers have investigated means of establishing plantations where it is possible to earn money from the trees ('Trees for Chickens'-project, 2012-2015). Another advantage of cover in the free-range area reported by Bestman et al. (in preparation) is that there is less risk of avian influenza. The leaching of nitrate and phosphate cannot be prevented by trees. Starting from a density of 2,500 hens per hectare, the density in both organic and conventional free range poultry husbandry, the chickens leave more minerals with their manure, than trees or other vegetation can take up (Bestman, 2015). In the Trees for Chickens project fruit trees, biomass willows and miscanthus have been tested on commercial farms. All were planted in

the period March till May 2013. The experiences highlight that the trees need to be managed in a professional way if the fruit trees are to be harvested. Not all poultry farmers are able to organize that. Therefore one of the Dutch topics in AGFORWARD is to investigate possibilities for cooperation between poultry farmers and professional fruit farmers (Bestman 2015; Bestman et al. 2015). This system description focuses on fruit trees in an organic free-range area on one of the Trees for Chickens' test farms.

3 Description of system

Table 1 provides a general description of the agroforestry system for organic egg production in The Netherlands. A description of a specific case study system is provided in Table 2.

Table 1. General description of the agroforestry system for organic egg production in the Netherlands

General description of system	
Name of group	Agroforestry for organic egg production in The Netherlands
Contact	Monique Bestman
Work-package	5: Agroforestry for livestock farmers
Geographical extent	Agroforestry systems for poultry production are found on two organic egg farms and on one free-range broiler farm in the middle of The Netherlands.
Estimated area	In 2012 there were 185 free-range egg farms and 127 organic egg farms with 4.5 million and 1.4 million hens respectively (PPE statistical year report). It is estimated that together they manage approximately 2,400[1] ha as free-range areas. Numbers of organic and free-range broilers are unknown but expected to be small, compared to the egg production. Although the interest in providing cover by planting trees is increasing among poultry farmers, still a small minority of the surface is planted substantially with trees. It is estimated that there is less than 5 ha of professional managed orchards in poultry free-range areas.
Typical soil types	Sand
Description	Dutch organic and free range laying hens have outside access year round. Only for a few weeks per year can weather conditions be used as a reason for keeping the pop-holes closed. More than 4 m² must be available per hen, which corresponds to 2,500 hens per hectare. There are no professional[2] poultry farmers with mobile housing. Rotational use is practiced on a very small scale: it is practiced by only a minority of the farms and they only keep small parts of land temporary free of chickens, mostly to let the vegetation recover. A typical hen's life-cycle is arriving on the laying farm when 17 to 18 weeks old, being kept inside until they lay eggs at 25 weeks and then have outside access continuously until they leave the farm at an age between 70 and 85 weeks. Depending on the farm management and the degree of cover in the

[1] 5.9 million x 4 m² = 2360 ha.

[2] According to environmental and veterinary regulations it is allowed to keep up to 249 chickens without being registered at the relevant agencies.

	range area, up to 80-90% of the hens can be seen outside, especially prior to sunset. However, on the majority of the farms, this will be 30-50% of the hens, mainly because of lack of cover. Organic laying hens have outside access already during rearing, from 8 weeks onwards and 1 m² per hen. With good cover and good weather conditions, at the end of the rearing, up to 40% of the young hens can be seen outside prior to sunset (Remijnse, personal communication).
Tree species	A number of poultry farms have several species of fruit trees such as apple, pear, prunes, and cherry. However, the number of trees is generally small and they are not managed in a professional way. Only a few farms are harvesting fruits from these trees. Three poultry farms have a professional orchard: an apple orchard on two egg farms and a cherry orchard on one broiler farm. Here the products are being sold as table fruit or apple juice.
Tree products	The crops will be harvested to produce hand fruit (apple and cherries) or fruit for juice (apple). The broiler farm with the cherry orchard sells orchard chickens[3] ('bongerdhoen').
Understory	The understory is grass, grass clover or weeds not eaten by chickens. However, on farms where hens go outside very well, large parts of the outdoor surface are bare. Grass in the range area which is not eaten (further away from the stable), is grazed by large animals (horses, cows or sheep) or mowed in order to keep it short. Too dense vegetation is not used by the hens.
Regulating services	The trees: • can provide shelter for the hens; • make the area less attractive for water birds and waders, which are known to be risk birds for avian influenza; • can reduce point load of nutrients because hens spread over a larger surface; • will increase carbon storage; • (in the green season) may capture dust from the poultry house, and • their management and the harvest are a diversification of the labour for (care) workers on the farm.
Habitat services and biodiversity	Increased attractiveness for singing birds, bees and other insects.

Table 2. Description of the specific case study system

Specific description of site	
Area	The case study system comprises of an organic egg production farm with 15,000 laying hens and 6 ha of free range area. The free range area is divided in five departments, each for 3,000 hens. 1.5 ha is planted with apple trees and 1 ha is planted with biomass willows. Under the fruit trees and on the remaining area grass is growing. The wood from the biomass willows is being used for heating on the conventional veal part of the farm. This system description will focus on the fruit trees on this farm.
Location of the farm	The farm is located in the province of Utrecht, in the Netherlands. 52°02'38.3'' N; 5°29'08.0'' E

[3] http://debongerdhoen.nl

Site contact	Monique Bestman
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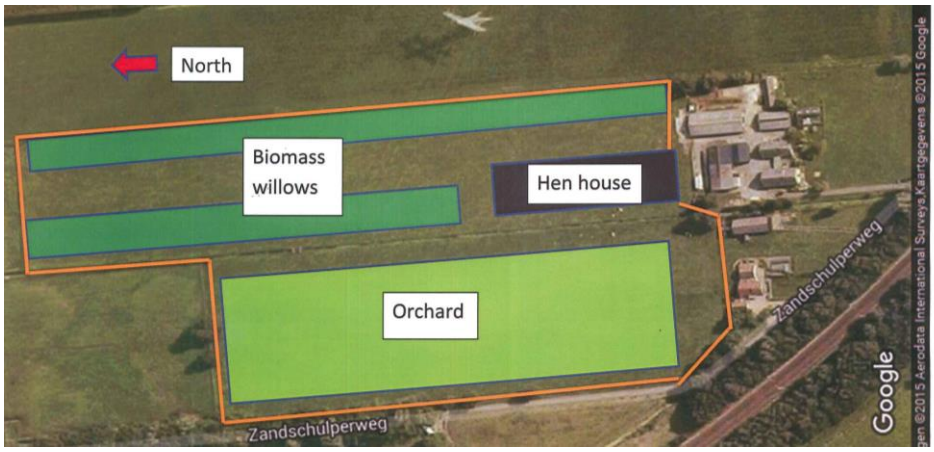
Example photographs	 Figure 1. Close to the stable there are stones in order to keep the soil dry. Next to the stone area there is a bare soil area, caused by the intense use by the hens. The border of the orchard is located at approximately 20 m from the stable.  Figure 2. Young trees approximately 6 months after planting. The stem protection is still there.

Map of system	 Figure 3. This is an edited aerial picture of the farm and the free range area
Possible modelling scenarios	
Comparison	Technical analysis of fruit trees vs biomass willows vs grass in a gradient from high to low chicken density depending on the distance to the stable.
Climate characteristics	
Mean monthly temperature	Mean yearly temperature is 10.1°C (min 6.0°C; max 14.1°C)
Mean monthly precipitation	Mean yearly precipitation is 832 mm (ranging from for example 42 mm in April to 83mm in October)
Details of weather station (and data)	Weather station located approximately 30 km from the farm.
Soil type	
Soil type	Sand
Soil depth	
Soil texture	
Tree characteristics	
Species and variety	Santana, Braeburn and Elstar
Date of planting	March 2013
Intra-row spacing	1.6 m
Inter-row spacing	3 m
Tree protection	In the first year after planting plastic wire cones were placed around the lowest 50 cm of the stems.
Typical increase in tree biomass	Not measured, but the trees are 2.0 – 2.5 m high.
Crop/understory characteristics	
Species	Grass
Management	Kept short by the hens or mown in parts further away from the stable
Typical grassland yield	Small, most is eaten directly by the chickens.
Fertilizer, pesticide, machinery and labour management	
Fertilizer	No, because it is an organic farm.
Pesticides	No, because it is an organic farm.
Machinery	Small mowing machine and small tractor for transportation of fruit crates

Manure handling	Naturally by the chickens and in spring application directly around the tree stems.
Labour	The farm provides labour and care for young disabled people.
Fencing	All compartments and ditches inside the range area are 'chicken fenced': one meter high gauze without electricity and without barbed wire. The outer border of the range area is 1.50 m high with barbed wire on top.
Livestock management	
Species and breed	Hybrid laying hens of modern brown genotypes.
Description of livestock system	According to EU organic regulation. Inside 6 hens m^{-2} and outside 2500 hens ha^{-1}. Hens are being kept from 17 to 77 weeks. They have outside access from 25 to 77 weeks. After they are culled, there is a two week period of empty stable prior to the arrival of the new 18-weeks old hens.
Date of entry and departure to site	Year round there are hens in the free range area, except for the nine weeks between culling the old hens and opening the popholes for the new hens. This nine-week period in 2015 was in early spring (March-April).
Stocking density	2500 hens per ha
Animal health and welfare issues	No
Requirement for supplementary feed	The hens receive a complete feed mixture for egg laying hens. The feed intake from the free-range area is negligible in terms of quantity. The amount of feed they eat inside the stable, so besides what they may eat outside, is of normal quantities known for brown egg laying genotypes.
Technical data, livestock	
Production volume	According to expected for these type of animals under these conditions: > 90 % egg production from 33 to 46 weeks and after that decrease to 72% at 77 weeks of age.
Feed consumption	According to expected for these type of animals under these conditions: 117 g hen^{-1} d^{-1} until 43 weeks. After that slowly decrease to 105 g hen^{-1} d^{-1} at 77 weeks of age. Additionally the hens received 5-8 g of grain automatically scattered in the litter.
N and P-balance, paddock level	There are no data available of this farm, but Dekker et al. (2012) calculated that on an organic farm (2500 hens/ha) with a an attractive outdoor run, resulting in year round a mean of 13% of the hens seen outside, yearly 340 kg N and 200 kg P ha^{-1} via the manure enters the free range area. This 200 kg P corresponds with 2.292[4] x 200 = 458 kg P_2O_5 ha^{-1} $year^{-1}$. Ehlert et al. (2009) report that apple and pear orchards yearly use 18-20 kg P_2O_5 ha^{-1}. This means that in general on poultry farms with 2500 hens ha^{-1}, there is a net gradual increase of P in the soil.
Financial and economic characteristics	
Costs	Egg production is the main income of the farm. Besides that, there is the income from housing the disabled people. The orchard does not have a net positive result yet.

[4] Conversion factor from P to P_2O_5.

4 Acknowledgements

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5 References

Bestman MWP, Wagenaar J (2003). Farm level factors associated with feather pecking damage in organic laying hens. Livestock Production Science 80: 133–140.

Bestman M (2015). Research and development protocol for agroforestry for free-range egg and poultry production in The Netherlands. AGFORWARD project. http://www.agforward.eu/index.php/en/agroforestry-for-poultry-systems-in-the-netherlands.html

Bestman M (2015). Uptake of N and P from poultry free range areas by plantation [in Dutch]. Internal project report by Louis Bolk Institute, Driebergen, the Netherlands.

Bestman M, Bloksma JR, Manintveld A. (2015). Chicken in the fruit and trees in the range area [in Dutch]. Ekoland July/August, p. 24-26.

Bestman M, Bloksma JR, Manintveld, Al. (2015). Fruit production in the range area: do it yourself, outsourcing or cooperation (in Dutch). Pluimveehouderij 4 September, p. 22-24.

Bestman M, Verwer C, Brenninkmeyer C, Willet A, Hinrichsen LK, Smajlhodzic F, Heerkens JLT, Gunnarsson S, Ferrante V (in preparation). Feather pecking and injurious pecking in organic laying hens in 107 flocks from 8 European countries.

Dekker SEM, Aarnink AJA, de Boer IJM, Groot Koerkamp PWG (2012). Total loss and distribution of nitrogen and phosphorus in the outdoor run of organic laying hens. British Poultry Science 53 (6): 731-740.

Ehlert PAI, van der Schoot JR, van der Visschers R, van Middelkoop JC, van der Maas MP, Pronk AA, van Dam AM (2009). Phosphorus content and phosphate drain of crops [in Dutch]. Alterra-rapport 1773, ISSN 1566-7197.

Green LE, Lewis K, Kimpton A, Nicol CJ (2000). A cross-sectional study of the prevalence of feather pecking damage in laying hens in alternative systems and its association with management and disease. Veterinary Record 147: 233–238.

Lambton SL, Knowles TG, Yorke C, Nicol CJ (2010). The risk factors affecting the development of gentle and severe feather pecking in loose housed laying hens. Applied Animal Behaviour Science 123: 32-42.

Mahboub HDH, Müller J, von Borell E (2004). Outdoor use, tonic immobility, heterophil/lymphocyte ratio and feather condition in free range laying hens of different genotype. British Poultry Science 45: 738–744.

Nicol CJ, Pötzsch C, Lewis K, Green LE (2003). Matched concurrent case-control study of risk factors for feather pecking damage in hens on free range commercial farms in the UK. British Poultry Science 44: 515–523.

PPE (2013). Statistical year report poultry meet and eggs 2012. Product board Poultry and Eggs. Zoetermeer, the Netherlands [in Dutch].

Remijnse W (2014). Personal communication. Organic rearer of laying hens, The Netherlands.

Trees for chickens (2012-2015). http://www.louisbolk.org/sustainable-agriculture/animal-welfare-2/trees-for-outdoor-chickens (accessed on 12 November2015).

Zeltner E, Hirt H (2003). Effect of artificial structuring on the use of laying hen runs in a free range system. British Poultry Science 44 (4): 533-537.