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Designing Socially Sound Poultry Farming—Matching Hen Ethology, Farm Management and Landscape Quality

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Abstract: In order to receive a licence to produce, poultry farmers have to take into account societal demands, among others: animal welfare, healthy working conditions for the workers and landscape quality. A way to reach a combination of these goals is to create a design for the poultry house and outdoor run. We propose a methodology based on five steps, which enables us to create a design that takes into consideration societal demands and that can be tested on its effects. These five steps are: 1. Giving a theoretical background on the societal demands (hen ethology, farm management and landscape quality) and based on this; 2. Giving a set of design criteria. 3. Describing the current state of the farm, in order to know its current qualities, 4. Making a design of the farm using the sets of criteria as guiding principle. 5. Reflecting on the design, to show whether the different criteria can be combined and where compromises are needed. A case study on an organic farm in the centre of the Netherlands showed that hen welfare, farm management and landscape quality can be improved together, although some measures do not add to all design criteria. Especially the effect on landscape quality and farm management is variable: the latter is also depending on the personal motivation of the farmer.

Key words: Outdoor poultry farming, hen ethology, landscape design, organic farming, poultry house, planting, Netherlands.

1. Introduction

More and more poultry farms are using an outdoor run. Some (interrelated) reasons for this switch are changes in societal demands, the growth of organic farming and changes in farmers' perspectives. There is an increasing awareness that animal keeping-and especially poultry farming-has to change to become socially acceptable [1-4]. This means that the hens should be kept in a more natural way, in a system that provides healthy working conditions for the farmer and on a farm that adds quality to the landscape. Research shows that the conventional cage systems are less and less accepted in this respect.

One of the answers to the changing views in society is organic farming, which is rapidly growing in the EU [5]: between 2002 and 2007 the annual growth rate was 6.2%. One of the issues in the conversion to organic poultry farming is the requirement for outdoor facilities. This raises the question how to structure the outdoor run in such a way that it is a healthy, safe and attractive place for the hens [6]. On health and welfare some research has been carried out [7-11]. It can be concluded that a close monitoring of the flocks is needed to keep them healthy in an outdoor system because, for instance, the hens can easily be infected with diseases, which can also spread rapidly through the flock.

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A less intensively studied subject is the hens' real use of the outdoor run [9, 12]. The available research shows that the hens use the area near the poultry house intensively, the middle part extensively, but that they hardly use the most remote part of the run. Shelter is an important means to guide the hens further away. At Elm farm research is conducted that will develop a kind of agroforestry system for hens, in order to be able to set better standards in organic poultry production [13].

So far, no research has been carried out on the effect of poultry farming on landscape quality. This is interesting because a sound landscape is an important requirement for societal acceptability of animal farming systems.

The aim of this paper is to give guidelines for a design process that includes several sets of requirements (in this case hen ethology, management and landscape). This design process was developed and tested on the basis of a case study.

2. Description

2.1 Steps in the Design Process

A design for a poultry farm was made using three sets of criteria: (1) hen ethology, (2) farm management and (3) landscape quality. The following steps were taken:

(1) Giving a theoretical background on hen ethology, farm management and landscape quality requirements on which design criteria can be based;

(2) Giving an explicit description of the three sets of design criteria;

(3) Describing the current state of the case study farm, in order to know what qualities can be used in the design;

(4) Making a design for the case study farm, using the sets of criteria as guiding principles;

(5) Evaluating of and reflecting on the design, to show where the different criteria can be matched and if not where compromises are needed.

2.2 Hen Ethology

2.2.1 Ethological Needs and Natural Behaviour

The modern layer hen originates from the red jungle fowl, a forest bird from Java. Although its behaviour and physiology have changed due to domestication and breeding based on production features, a large part of its natural behaviour is still the same as that of the red jungle fowl.

Behaviour is the expression of the interaction between the animal's needs and its surroundings. The essential needs for the maintenance of the normal physiological, physical and psychological state of the animal are called the ethological needs of the animal. For a layer these are: food and water intake, dust bathing, foraging, exploration behaviour, perching, nesting and egg laying, social behaviour and resting [4]. Non-fulfilment of these ethological needs will lead to abnormal behaviour such as feather pecking and cannibalism. Therefore the ethological needs should be met in a poultry housing system. Natural behaviour is more than the fulfilment of ethological needs, it also includes sexual behaviour, aggression, health, escape and fear behaviour, sunbathing and food diversity. Hens exercise this behaviour when the environment permits, and there is a reason to believe that the hens need this for their well-being [8, 14]. Housing systems with an outdoor run will allow the hens to exercise this natural behaviour [9].

2.2.2 Criteria for Hen Welfare

Based on the ethological needs and natural behaviour of the hens the following criteria for hen welfare have been defined by organic agricultural movement [15]. The flocks in organic poultry keeping are not to exceed 3,000 hens, with a minimum space per hen of 4 m^2 (1 m^2 per pullet). The hens should have the possibility to search for food (cereals, worms and insects), have permanent access to water in the run and have the possibility to take dust baths. As a forest animal the hens need a year-round cover/protection from above, in the form of permanent vegetation, with open spaces not wider than 15 m (Fig. 1A). The hen

should have the possibility to explore, but the distance to the poultry house should not exceed 200 m, since 50% of the hens do not venture out more than 150 m and 90% not more than 200 m [16].

Direct sunlight into the poultry house openings has to be avoided, since this would give too strong a contrast in light between the inside and outside, which would deter the hens from going outside. The openings must also be protected against strong cold winds, to avoid draught inside the poultry house [17].

2.3 Farm Management

2.3.1 The Roles of a Poultry Farmer

The poultry farmer has to fulfil three roles [14]. He is a worker, a businessman and an animal keeper. With each role comes a specific set of needs. As a worker the poultry farmer wants to minimize the workload, to carry out the work in an effective way and to work in a healthy workspace. As a businessman the poultry farmer's needs are continuity for his business, producing quality products and sustainability. Therefore, it is important that the laying hens are healthy, produce many eggs and remain in good condition. Furthermore, the businessman needs space for entrepreneurship and maintain a good public image. The needs as an animal keeper are to be in contact with his hens, to work with them, to protect them from negative influences and to be socially responsible for them. Depending on the farmers priorities the roles differ; therefore, a design should be made for a specific poultry farmer.

2.3.2 Criteria for Suitable Farm Management

Based on the roles of the poultry farmers, the following criteria can be defined. The poultry keeper wants a low-maintenance run. Therefore, most plants should be permanent. For the annual crops the sowing can be done with machines (4-5 m wide). The run must have an entrance of at least three meters wide to allow machines to enter the field and to have enough manoeuvring space.

For sanitary reasons the first zone outside the poultry house is filled with wood chips, which can be replaced. This zone should have an easy access for machinery. The production of the wood chips can be done in the run (150-200 m^3). These wood chips can be re-used for soil improvement and need to be composted in a compost heap. There should be no open water in the outdoor run as a sanitary precaution, so as not to attract water birds. To keep foxes out of the run electric fences are needed. There should be enough shelter facilities to protect the hens against birds of prey. To allow for the regeneration of the plant life, and as a sanitary precaution, rotation compartments should be applied for the first 20 m

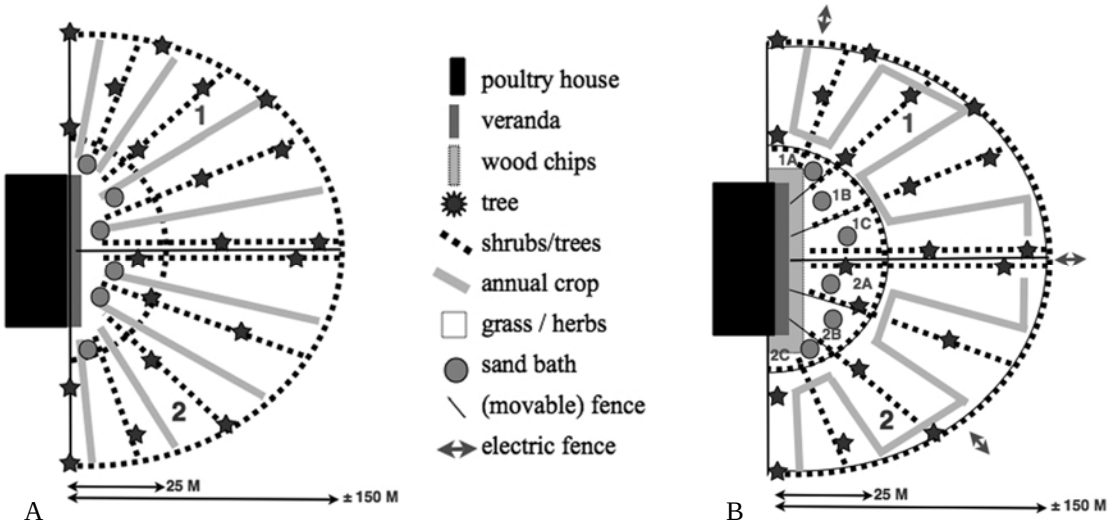

Fig. 1 A: Model outdoor run according to hen ethology criteria, containing two flocks; B: Model outdoor run including management criteria (see text for further explanation).

behind the wood chips zone. Access alleys provide a link between the wood chips area and the rest of the run (Fig. 1B; sections 1a, 1b, 1c etc.). Use of these is rotated for the sake of sanitation and to allow regeneration of the vegetation. These access alleys are rather wide to avoid them being a bottleneck in the system. The strips of annual crops (e.g. cereal) provide shelter and are designed to encourage the hens to disperse throughout the run.

2.4 Landscape Quality

2.4.1 Landscape Quality of Farms

Landscape quality is viewed differently by different people and different disciplines and has been interpreted differently throughout history [18-20]. In this contribution we have chosen to see landscape quality as the possibility to read the landscape, in other words as the legibility of landscape. This choice ties in with the way people experience landscape [21, 22], it is in line with the European Landscape convention [23] and it recognizes the fundamental need of people to orientate themselves in space and time [24, 25]. Legibility can be defined as the extent to which a landscape system (abiotic, biotic and anthropogenic factors) is expressed in the landscape image [26, 27]. The better the coherence between system and image, the higher the landscape quality is, because then site- and time-specific features are strongly shown.

2.4.2 Criteria for Landscape Quality

Based on the legibility theory of landscape the following criteria can be defined [26, 27]. Four types of coherence contribute to the expression of the site- and time-specific landscape features. They can be formulated as four criteria for the legibility of a farm landscape.

(1) Vertical coherence: The farm image expresses the soil type, the geomorphological circumstances and the differences in water table;

(2) Horizontal coherence: The farm image expresses functional, ecological and hydrological differences in the patterns of ditches, in the visibility of parcelling, in the spatial character, in the situation of the buildings in the landscape and the layout of the farm and the yard;

(3) Seasonal coherence: The farm image expresses the moment in the year in colour and form of the vegetation (year round perception) [28];

(4) Historical coherence: The farm image shows the development of the area, visible in the natural and cultural elements and patterns like parcelling, ditches, planting and infrastructure.

3. Results

3.1 Analysis of the Case Study Farm "Lankerse Hof"

3.1.1 The Farm

The case study farm Lankerse Hof, is located in the Gelder Valley west of the town of Voorthuizen (Fig. 2). The farm has been certified organic since 1999. At present there are 6,000 hens on approximately 5 ha. The farmer wants to increase the number of layers from 6,000 to 12,000 and wants to introduce 6,000 pullets in addition. A new poultry house has to be built and the area has to match the requirements of the 18,000 hens, the poultry keeper and the landscape.

3.1.2 The Landscape of the Area

The farm is situated in an old agrarian landscape. The sandy Veluwe massive is situated to the east; more to the west one can find peat in the lower parts of the valley. In the 19th and early 20th century, the area consisted of a mix of heathland on the higher sandy areas, wet pastures and hay meadows near the brooks and in the peat area (Fig. 2). The villages, farm buildings and the arable fields were situated between the heath and the grasslands. Most of the arable fields were relatively small compared to the vast heatlands. The edges of the arable fields were planted with bushes and trees, to protect the crops from cattle grazing in the nearby pastures. Nowadays parts of the old landscape structure can still be found. The road along the farm is the old enclosure road to the former

Fig. 2 Aerial photograph showing the location and the actual lay-out of the Lankerse Hof.

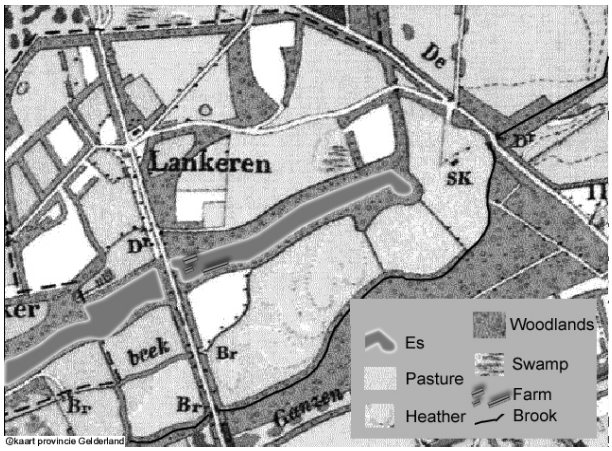

Fig. 3 Fragment of historical map showing the small scale mixture of heather, arable land (es), pastures, hay meadows, swamps, wood lots and brook valleys typical for this region.

manor house of Lankeren (Fig. 3). Where this road leads over the old arable field ('es' in Dutch) it is bordered by old oaks, in the lower brook area the road planting is ash. In some parts the relief is still visible, in other places it has been removed. The land use is not as coherently related with the soil types as before; arable fields and pastures can be found everywhere. New buildings are built near the new roads, even in the (former) wetter areas. Straight lines took over curved lines and the variation in spaciousness has diminished. Some relics of the plantings on the edges of the old arable fields can still be found in the area.

3.1.3 The Farm Landscape

The farmhouse of Lankerse Hof was built in 1923 and included living quarters, cattle and storage sheds. A poultry house for 6,000 layers was built in the 1980's and is situated behind the house (Fig. 4). Some signs of former land use can be found. The lower and relatively wetter parts of the farm are still in use as grassland, the higher and drier part is used as arable land. The old arable field structure can be recognized, although part of the relief has been removed by transferring some soil to the lower wetter part. Because of the more intensive use, the vegetation composition of both the grassland and the herbs on the arable land has diminished. The natural vegetation on the sides of ditches and roads does not reflect the qualities of the area any more, although the organic management has led to some more variety in the last few years. The same counts for the seasonal aspects: after a period of decrease of colours and forms, there is an increasing expression of the seasons because of the organic management and the planting of trees and shrubs.

3.2 A Landscape Design for Case Study Farm "Lankerse Hof"

This paragraph gives ideas for the design of the new farm lay-out, sometimes providing alternative solutions. Given the changes that will take place on the farm, the challenge is to create a design that improves the quality of the landscape, farm management and hen welfare simultaneously. We concentrate on the location of the new poultry house and the layout of crops and planting (Fig. 5).

3.2.1 Location of the New Poultry House

The farmer already has permission to build a new poultry house near the old one (Fig. 6). However, this would create a fragmented building block. Instead we propose to create the new building near the neighbour's buildings (Fig. 7). This is positive for the hens because their housing is centrally located on the farm land, so the flocks can use the area more effectively. The eastern flock can even reach the end of the outdoor run. The positive aspect for the poultry keeper is that due to the larger size (width) of the runs

Fig. 4 View from the south (Fig. 2) with the Lankerse Hof on the left hand, showing the relative openness of the farm's surroundings and the immense cattle houses of the neighbouring farm.

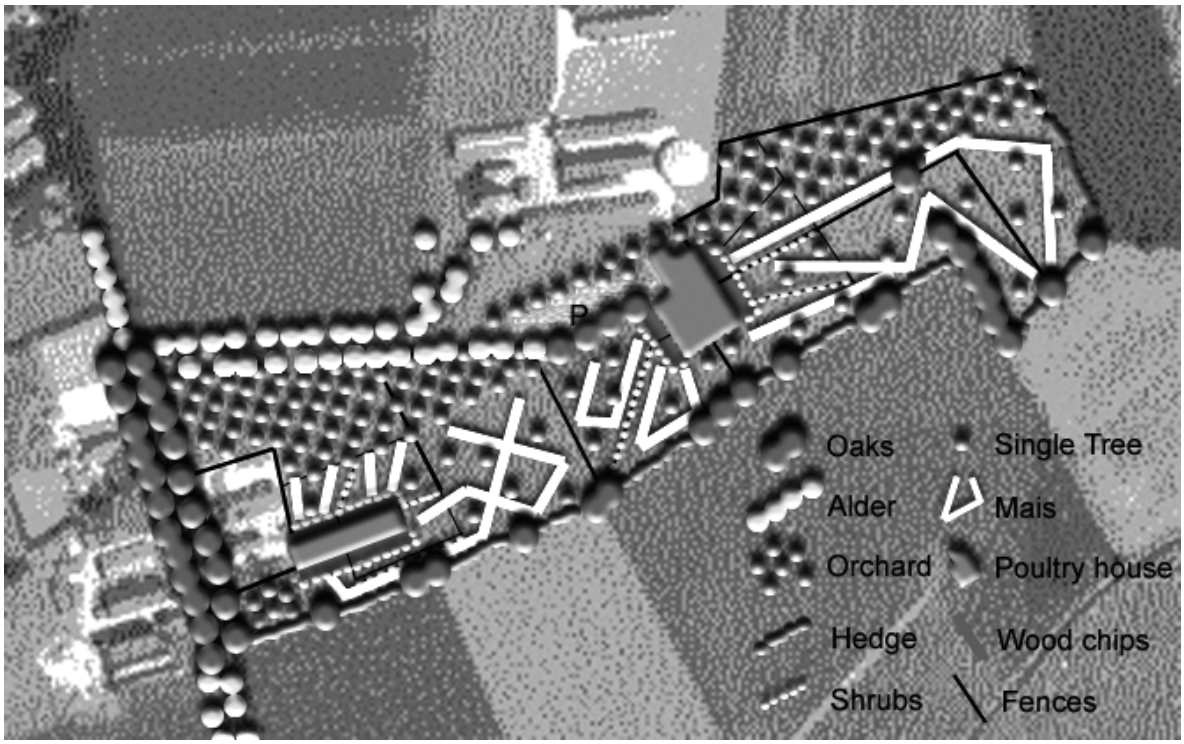

Fig. 5 Landscape design based on criteria for hen ethology, farm management and landscape quality.

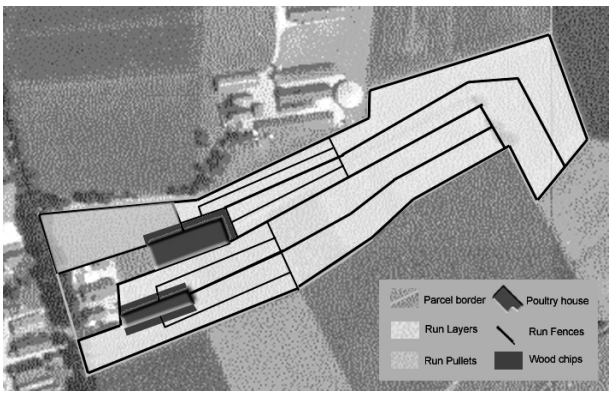

Fig. 6 Situation if the new poultry house will be built near the existing poultry house.

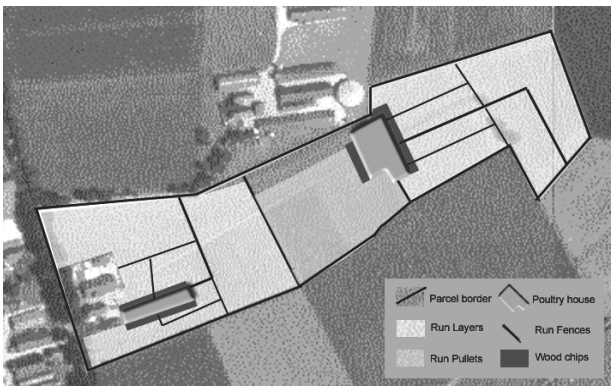

Fig. 7 New proposal, with the new poultry house near the neighbour's buildings.

and subsequent better spreading of the hens, the disease pressure is lower. The poultry house can easily be reached by the farmer and by trucks via the existing road and a short new road. An additional positive effect of that is that the trucks do not have to cross the farmyard anymore, which is also a private space. The clustering of the poultry house with the neighbour's buildings maintains an open view between the two complexes (contributing to landscape quality, more precisely to horizontal coherence).

3.2.2 Application of Crops and Planting

In the design planting is crucial. Planting is needed for the hens, but also for harvesting wood chips. If well applied, it can also improve the landscape quality. We shall discuss three measures, (1) planting trees and shrubs, (2) planting orchards and (3) growing annual crops, and we shall describe their benefits.

By planting shrubs like hawthorn, blackthorn and oak on the edge of the old arable field, the old landscape structure can be reinstated and become visible again (contributing to horizontal and historical coherence). The flowers and berries of these shrubs provide year-round visual interest and a source of food for the hens (contributing to seasonal coherence). But the most important aspect of these shrubs is that they provide cover and the possibility for hens to express their natural behaviour. The ditch on the north side, as well as the new road to the new poultry house, can be planted with alder. This road is situated in the lower, wetter part of the farm and this is the natural habitat of alder (contributing to vertical coherence). The southern edge of the old arable field can be emphasized by oak trees and hedges, the northern side with some oaks at the parking lot and orchards, as a historical reference to the wood lots around arable fields that used to exist in this area.

Hens need cover throughout the outdoor system. So also the brook valley and the former grassland, have to be planted. We propose to plant two orchards. The western orchard can be planted with walnut trees, while – because of the wetter conditions-the eastern orchard can be planted with hazelnut, willow and poplar (contributing to vertical coherence). The orchard provides wood for wood chips, free food and cover for the hens. More woody elements in the brook valley are totally in line with the historical situation of the region (contributing to historical coherence).

Cereals can be grown on the former arable field. The soil is very suitable for arable farming. The cereals (possibly with grass under sown) that are shown here provide fodder, a fast growing cover and an attraction for the hens. It also adds a sense of history to the area (contributing to historical coherence). In addition, some trees will be planted, because in times that the annual crop is too small yet or already harvested the cover is not sufficient. Shrubs are planted near the poultry house and single trees offering partial screening, e.g. rowan and fruit trees further down the run.

4. Discussion

4.1 Reflection on the Design

Most of the design measures can serve all criteria described; however, sometimes a compromise is needed (Table 1).

4.1.1 Hen Ethology

It is to be expected that the hens will be happy with the new design because they can display their natural behaviour better than in the old situation. Due to a better positioning of the poultry house they can optimally use the area and the variety of planting will guide them away from the poultry house, making them use the whole area. However, the chances that they will be caught by a bird of prey are enlarged. The planting structure is designed to allow the hens to find enough shelter against such attacks.

4.1.2 Farm Management

The new situation will bring additional work for the farmer (external housing, managing planting and difficulties with manoeuvring). This can be a problem for the worker in the poultry farmer, but it depends on the personal situation of the farmer-amount of labour available, personal preferences-whether this indeed is a problem. The businessman in the poultry farmer will be satisfied because this new way of working produces quality eggs (in the sense that he can label them as organic) in a sustainable system. Probably the animal keeper will be most content because his hens are happy at the same time.

4.1.3 Landscape Quality

The new poultry house will cross the edge of the old arable field, which make the landscape structure

less visible. From a landscape point of view the building would be best placed near the existing farmyard parallel to the neighbouring building, to prevent reduction of the open space. However, for the hens the layout of the outdoor run is not optimal in that situation. The openings in the poultry house cannot be located towards the south or the north-east and this will lead to problems with rain and lack of sunshine.

The application of crops and planting contributes to all four landscape criteria, except for the planting on the old arable field. Here the planting is unhistorical and diminishes the clear landscape structure (horizontal coherence). However, the old arable field will still be used for arable farming with cereals, which will add to the historical character of this landscape element. Other planting is needed to give the hens year-round cover. Here, the use of shrubs and small trees is a compromise. This also counts for the creation of the orchard, which will diminish the vistas through the farm (Fig. 5).

4.2 Reflection on the Methodology

4.2.1 Evaluating the Effects

We propose a methodology based on five steps, which enables us to create a design that can be tested and falsified. A case study in the centre of the Netherlands showed that working with this methodology leads to a well-grounded design, with clear measurable output. However, because few empirical data on hen behaviour in outdoor runs is available, it is necessary to carefully monitor the situation when the design is applied. On a theoretical basis it can be concluded that in the design hen welfare, farm management and landscape quality will jointly be improved, although some measures do not add to all design criteria. Especially the effect on landscape quality and farm management is variable: the latter also depends on the personal motivation of the farmer and the role that is most important to him (Table 1).

Table 1 Matching measures and societal demands.

	Hens	Poultry keeper	Landscape
New poultry house	+	+	+/-
Trees and shrubs	+	+/-	+
Orchard	+	+/-	+
Annual crops	+	+	+

+ = positive, +/- = neutral or unclear yet, - negative. The table shows that all design elements have a positive effect on hen welfare, a positive or indifferent effect on landscape and that the effect on the poultry keeper depends on the role which is most important for him (worker, businessman, animal keeper).

4.2.2 Stakeholder Involvement

The method was applied and tested by scientists, who regularly checked their findings with the farmer. However, the starting point of the method was to take into account societal demands. In our case the criteria for the design were based on literature about societal demands. A next step would be to involve stakeholders in discussion platforms consisting of consumers and inhabitants of the region [29]. Especially the landscape method we have applied has proven that it can easily be used together with the layman [30, 31].

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