

Refinements in rabbit husbandry

**SECOND REPORT OF THE BVAAWF/FRAME/RSPCA/UFAW
JOINT WORKING GROUP ON REFINEMENT**

Contents	Pages
Preface.....	302
Aims of the report.....	302
1. Introduction.....	303
1.1 A brief history of rabbitkeeping.....	303
1.2 History of rabbit breeds.....	304
1.3 Rabbits in research.....	304
1.4 Rabbit caging.....	304
2. Group housing in pens.....	305
2.1 Introduction.....	305
2.2 Group compatibility.....	305
2.3 Size of pens and stocking density.....	307
2.4 Establishing groups.....	308
2.5 General Husbandry.....	309
2.6 Environmental enrichment.....	312
2.7 Catching and handling.....	313
2.8 Identification.....	314
2.9 Breeding.....	314
2.10 Health.....	315
2.11 Running costs.....	316
2.12 Advantages and disadvantages of group housing rabbits.....	317
3. Caged rabbits.....	319
3.1 Introduction.....	319
3.2 Cage design - size.....	319
3.3 Cage material and floors.....	321
3.4 Substrate and tray liners.....	321
3.5 Mechanical flushing systems.....	322
3.6 Food and water.....	322
3.7 Lighting.....	322
3.8 Temperature, relative humidity, ventilation.....	322
3.9 Stereotyped behaviour.....	323

3.10 Environmental enrichment for caging.....	324
3.11 Advantages and disadvantages of caging.....	324
4. Conclusions.....	325
Appendix 1 - Natural behaviour patterns carried out by rabbits.....	325
Appendix 2 - Research recommendations.....	327
References.....	327
Additional information.....	329

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PREFACE

Whenever animals are used in laboratories, minimizing any pain and distress they suffer should be as important an objective as achieving the experimental results. The refinement of procedures to make them more humane should now be an integral part of all scientific research. This is important both from humanitarian concerns and in order to satisfy the requirements of the Animals (Scientific Procedures) Act 1986.

In recent years, more attention has been focused on the need to recognize and control adverse effects of scientific procedures on animals. Similarly, attention is being paid to the need to improve and enrich the environment in which laboratory animals spend their lives. There is, however, still a great deal of scope for improving current laboratory practice for the benefit of animal welfare. Such improvements can also enhance the quality of scientific research, since suffering and distress in animals can result in physiological changes which are likely to add variables to experimental results and, at worst, may even invalidate the research.

Significant improvements in laboratory techniques and animal husbandry can be made immediately in several ways. In order, to do this, unequivocal and up to date information on all aspects of laboratory animal care and use must be readily available. Concern over the need to provide such information led to the Royal Society for the Prevention of Cruelty to Animals (RSPCA), the Fund for the Replacement of Animals in Medical Experiments (FRAME), the Universities Federation for Animal Welfare (UFAW) and the British Veterinary Association Animal Welfare Foundation (BVAAWF) establishing a Joint Working Group on Refinement in 1989. The aim of the group was to set up a series of working parties to discuss ways that common laboratory procedures could be refined to minimize any pain or distress caused to laboratory animals. The members of each Working Party were drawn from the scientific community, from industry, academia and from animal welfare organizations.

Each working Party addressed a single topic, the proceedings being published in *Laboratory Animals*. The present report, entitled *Refinements in Rabbit Husbandry*, is the second of the series.* It describes ways in which the current systems of housing rabbits can be improved by group housing or by enriching the environment of individual cages.

Some of the contributors are opposed to the use of animals in experiments that may cause the animals pain, suffering or distress. However, they share with many in science the common aim of reducing animal suffering wherever it occurs. The reports of these refinement workshops are intended to help achieve that aim, particularly if they are read in conjunction with other recent reports on the recognition, measurement and alleviation of pain or distress in animals.

It is hoped that the reports will be widely circulated, both in the UK within establishments designated under the Animals (Scientific Procedures) Act 1986, and in other countries, and that the recommendations contained therein will be adopted as 'Best Laboratory Practice'.

*The first report - *Removal of Blood from Laboratory Mammals and Birds* - appeared in *Laboratory Animals* (1993), **27**, 1-22.

AIMS OF THE REPORT

The aims of this report are to identify the needs of domesticated rabbits and to present information on ways in which the current systems of housing rabbits can be improved for the benefit of all concerned: the animal, the scientist, the animal technician and the breeder.

In recent years an increasing number of establishments have changed from standard caging to group housing systems, despite the traditionally held view that mature rabbits cannot be housed together. In this report group housing in floor pens is discussed in detail (Section 2), with both the advantages and disadvantages of this system presented. It is recognized that group housing may not always be possible and so in Section 3 ways of improving single caging systems are also described.

The report summarizes published information and the practical experience of Working Party members. Recommendations are based on both, but where the data are considered inadequate, a majority view is given.

The housing systems and current guidelines referred to in the report have a UK bias. However, the principles discussed and recommendations made are applicable worldwide.

1 INTRODUCTION

The welfare of all domesticated animals is very important, whatever the purpose for which they are kept or used. Humanitarian and scientific concern for the physiological and behavioural needs of farm and laboratory animals is increasing, and as a result, more attention is being given to improving the conditions in which the animals are kept.

In the UK, guidelines on the housing and care of rabbits have been produced by the Home Office (HO) (1989), the Ministry of Agriculture, Fisheries and Food (MAFF) (1971, 1990) and the Laboratory Animal Breeders' Association (LABA) (1991). These outline minimum requirements. Rabbits, however, are social animals, able to utilize complex three-dimensional environments, and it is unlikely that the common practice of housing them singly in bare cages will satisfy many of their behavioural needs. Moreover, such methods of housing may have serious implications for research, since the animals may produce abnormal physiological and ethological responses.

The welfare of animals can undoubtedly be enhanced by enriching their environment and improving their housing and care. This may even lead to better breeding performance and rate of growth. When animals are used for research, there may also be fewer artefacts, so that more reliable and reproducible scientific data are obtained, which, in turn, should lead to fewer animals being used.

The needs of domesticated animals can be evaluated by examining the behaviour of their wild relatives. (An ethogram describing the range of rabbit behavioural patterns is included as Appendix 1). Comparative studies of domesticated rabbits living in groups in large enclosures have shown they retain the full behavioural repertoire of their wild type ancestors (e.g. Bell, 1984; Lehmann, 1989). There is increasing evidence to show that rabbits denied such freedom actually lose the ability to move normally and suffer permanent skeletal abnormalities. For example, in a series of morphological and histological studies Drescher & Loeffler (1991) showed that caged rabbits suffered an inactivity hypoplasia of the bone

tissues. This predisposes the rabbits to fractures and can cause considerable discomfort by trapping nerves in the vertebral column (see also Lehmann, 1984, 1989; Wieser, 1986; Stauffacher, 1991; Rothfritz *et al.*, 1992). For practical systems of husbandry rabbits have to be confined, but it is essential they should still have adequate room to perform the majority of their natural locomotory behaviours, despite the obvious spatial constraints. The rabbit is a naturally gregarious species so attention should also be paid to their social, as well as to their physical, wellbeing. In this way the stereotyped behaviours so commonly seen in singly caged rabbits can be reduced.

Whatever system of housing animals is employed, there is an absolute necessity for good husbandry practices and good stockmanship. Furthermore, in the case of laboratory animals the need for familiarization with humans by regular handling is very important, since in this way distress is minimized and scientific procedures, such as blood sampling, are facilitated.

1.1 A brief history of rabbit keeping

Rabbits were introduced into Britain by the Normans soon after the Conquest of 1066. They were originally kept and bred in warrens for meat and fur - a warren being an open or closed area of land which could consist of several hundred acres. Closed warrens were often surrounded by stone or turf walls some 6 feet high, the latter being capped with furze, blackthorn or reeds. From 2 to 8 rabbits were allowed to winter per acre, one buck to 6 or 7 does. The common-grey, silver-grey and black rabbits were the main breeds of warren rabbits.

Coloured rabbits were often kept in parklands. Some escaped and interbred with the common-grey and were called parkers (Sheail, 1972). Rabbits were housed in every conceivable manner by utilizing pits, cellars, boxes, barrels, outbuildings and by constructing rabbit courts. Rabbit courts were often built between two south-facing buildings to allow for the maximum amount of sunshine during the summer months. The high walls offered protection from the wind and a flagstone floor provided containment. Each breeding female had its own 'open' hutch which could be closed if required. A court could contain 12 breeding females and young of a hardy strain (Cuniculus, 1885).

By the end of the 19th century the wild rabbit had fully established itself, helped by agrarian progress and the hedgerow. Trapping and ferreting were thus more profitable than maintaining a warren. Rabbit-keeping increased again during the two world wars as a means of converting waste food and surplus garden produce into edible meat (MAFF 1971). The larger breeds (pure and crossed) were popular for meat production, and dual-purpose breeds, like the chinchilla, were bred for their fur.

1.2 History of rabbit breeds

Trading between nations saw the introduction of a wide variety of rabbits into Britain. It is said, for example, that the Himalayan originated from Northern India and China (Knight, 1889). However, rabbits were mainly imported from European countries such as Belgium and France.

The Angora was in existence prior to 1723, but it was not until the beginning of the

19th century that rabbits were bred for uniformity, size, shape and colour. By the mid- to late-19th century about 13 breeds of rabbit had been established including the Lop, Dutch and Patagonian. The Patagonian is now extinct but was one of the oldest breeds of giant rabbits (weighing up to 9 kg). It can in fact be traced back to the 16th century and was probably the forerunner of the Flemish Giant (Brown, 1982).

During the first half of the 20th century many new breeds of rabbit were created by cross and selective breeding. The New Zealand White, for example, was accepted into the American Standard in 1925. Its ancestry contains the bloodlines of the Flemish Giant, Angora and American White. Rex rabbits originated from mutations in 1919, as did the Satins during the 1930's. The Californian, an American breed, was established in 1923. The breed combines the size of the New Zealand White, the quality of fur of the Chinchilla and the fine bone structure of the Himalayan. Commercial rabbit breeders who specialize in the production of meat and fur primarily breed New Zealand Whites and Californians. These breeds are selected for their fast growth rate and their white pelts which can be dyed any colour. Today, there are 76 recognized breeds of fancy fur and rex rabbits (British Rabbit Council, 1991).

1.3 Rabbits in research

Rabbits are one of the more commonly used laboratory animals. In 1991, 41,927 rabbits were used in scientific procedures in Great Britain (Home Office, 1992). The main breeds of rabbit bred and used for research are the New Zealand White, the Dutch and the Half Lop. In the past, rabbits used in biomedical research were mainly purchased from dealers who obtained them from a wide range of sources including cattle markets (Bleby, 1967). However, scientists became increasingly concerned about the poor quality of such animals and the effect this had on the quality of biological research. The quality and supply of rabbits for research improved dramatically with the introduction of the Medical Research Council's Accreditation Scheme (Townsend, 1969; Eveleigh *et al.*, 1984). The momentum has been maintained through the Laboratory Animal Breeders' Association Accreditation Scheme (LABA, 1991) and the requirement under Schedule 2 of the Animals (Scientific Procedures) Act 1986 that rabbits for research must come from designated breeders and suppliers.

1.4 Rabbit caging

Exhibition and pet rabbits are housed in solid-floor, wooden cages of a wide variety of shapes and sizes. Most commercial breeders however, for both economic and husbandry reasons, prefer to breed and maintain their stocks in galvanized woven mesh suspended cages. Caging for rabbits used for research purposes has changed through the decades from traditional wooden hutches to galvanized iron, aluminium, stainless steel and now plastic caging, with Home Office guidelines enforcing increased cage sizes (Home Office, 1989). In research laboratories, rabbits are traditionally housed singly in barren environments often over periods of months or even years. The types of cages employed are seemingly adequate to meet the animals' basic health needs. A bare cage is, however, unlikely to satisfy many of their

behavioural requirements or needs and therefore has the potential to adversely affect their physiological and psychological (or mental) well-being, as evidenced for example, by abnormal behaviours. This, in turn, may influence research results and the potential adverse effects of such caging should be investigated.

In practice there is a limit to the amount of space for animal accommodation in an experimental facility, but it is important to try to optimize that which is available. It may be advantageous to change from caging to a penning system, which may or may not be on the floor, with emphasis on environmental enrichment. Depending on the facility, small groups of rabbits could be kept in individual pens within an animal room, or larger groups could be housed in an entire room. Even if this is not possible, it is very important to enrich the environment of the conventional single cage.

2 GROUP HOUSING IN PENS

2.1 Introduction

Rabbits housed in social groups benefit both from the company of others and from exercise (Heath & Stott, 1990; Batchelor, 1991). In addition, abnormal physiological and psychological conditions may be reduced. However, care must be taken since other problems such as bullying and fighting may arise, which do not occur with individually caged animals. The overall benefits of group housing nevertheless greatly exceed those for single caging.

Practical systems of group housing rabbits have been largely successful and should be encouraged (Fig.1). Rabbits may still sometimes have to be housed individually for health or experimental reasons. This is still possible within group housing systems, since large animal pens (e.g. dog pens) or animal rooms can be modified to accommodate individual rabbits, by dividing the space into smaller areas.

The major factors to consider when group housing rabbits in pens are:

- *compatibility of individual animals
- * size of pens
- * stocking densities
- * husbandry practices
- * environmental enrichment

These are discussed below.

2.2 Group compatibility

It is essential that group housed rabbits be compatible, but rabbits can be aggressive and it is recognized that mixing strange animals together will cause them to fight and possibly damage each other, though wounds are rarely fatal. This can apply both before and after they reach sexual maturity. Mature females can be settled down, but it is more difficult to group mature males, especially in the presence of nearby females. It should be assumed that animals which have not been reared together will be aggressive when they are mixed.

The degree of compatibility of grouped animals will depend on factors such as strain, individuality, genetic relatedness, age and weight, sex, size of pens, methods of husbandry, the handlers, environmental enrichment and proximity, of the opposite sex (Adams, 1976;

Kraft, 1979a,b; Bell & Bray, 1984; Zain, 1988).

In general, animals for group housing should be of the same sex, of similar size and, if possible, related and grouped when young, i.e. around the time of weaning. The importance of continued monitoring of a colony cannot be overemphasized.

2.2.1 Strain

Some strains appear more aggressive than others. Dutch rabbits are generally more aggressive than New Zealand Whites. Lops are basically more docile, although this can vary with the individual strain of lop. Docility should be evaluated in terms of ease of handling, as well as of lack of aggression both during breeding and when mixing with other rabbits.

Whatever strain is used in research, it seems sensible to select docile animals for breeding. Breeders should be consulted about the strains of animals most suitable for group housing and asked to breed accordingly. Unlike farming practice, there may be no advantage in selecting for rapid bodyweight gains.

2.2.2 The individual animal

Individual rabbits (male or female) may be highly aggressive, and males in particular are likely to form dominance hierarchies when grouped together in a confined area (Stodart & Myers, 1964; Kraft, 1979a,b; Bray, 1987; Bell, 1984). In order to avoid bullying, groups need to be carefully selected and subsequently monitored at regular intervals since trouble can sometimes flare up for unknown reasons, even in a group that has been stable for a long period. Sometimes the bully (or perhaps the subordinate animal) may have to be removed temporarily to a cage, or may have to be permanently housed on its own.

It is always important to provide refuges and hiding places for subordinate animals to escape any possible persecution.

2.2.3 Age at grouping

Ideally, rabbits for group housing should be litter mates which have been kept together from weaning (Zain, 1988). If this is too restrictive in terms of group size then litters can be mixed, but the younger they are when grouped, the less likelihood there is of problems with aggressive behaviour. Keeping animals together from weaning avoids disturbing group stability. This is easy when rabbits are bred in-house. If animals are bought in it is best to select a breeder who routinely group houses them, and to buy litter mates at weaning and grow them on.

The effect of age on behaviour in this context revolves around sexual maturity, with males tending to be more difficult to group house than females. There are, therefore, problems in keeping groups of mature rabbits together, but these are by no means insurmountable (see Section 2.4).

2.2.4 Sex

Females: Groups of intact, mature female rabbits not intended for breeding can be kept together. (Maturity is attained at 3 to 5 months of age, depending on the breed.) However, it is preferable for the animals to be siblings, or to have been reared together from weaning. Fighting, however, can still occur, for example, a dominant female in oestrus will mount and damage the skin on the backs of other females and may generally harass the group. The

dominant or the subordinate animal may have to be permanently separated as a result. The group may then settle or another doe may become aggressively dominant. Large weight or age differences also seem to lead to aggression.

Females kept together may be in a state of pseudopregnancy. If they are to be used for breeding it will take up to 3 weeks after separation from the group before they come into oestrus.

Males: Aggression between males seems to be a problem particularly when there is competition for territory, mates or food. Groups of males kept in the proximity of females tend to fight and urinate more frequently (Portsmouth, 1987).

It may be necessary to house mature males (around 10 weeks of age) individually to avoid fighting. It has been suggested that castration of mature males, as is done with some pet animals, may help avoid aggressive behaviour, but little experimental evidence is available on this point. The experience of some members of the Working Party and that of Love and Hammond (1991) suggests it is worth trying. Gunn (pers. comm., 1993) studied aggression in 2 groups of 5 mature males before and after castration. Levels of aggression were reduced and both groups remained stable 7 months after post-operative regrouping. Castration should be carried out 3-4 weeks after weaning, i.e. before males start to show aggressive behaviour. N.B. Castration will affect the animals' physiology, therefore the research for which the animals are to be used should be taken into account, in case there is a conflict of interests.

Some members of the Working Party were unhappy at recommending a surgical intervention in order to accommodate a particular husbandry system, albeit one designed to address other aspects of welfare. There is clearly a dilemma here and each individual situation will need to be carefully evaluated. Castration may only be appropriate if male rabbits are to be kept for long periods.

2.2.5 Pen size, husbandry and environmental enrichment

Good husbandry and environmental enrichment can reduce aggressive behaviour (see Sections 2.4.1 and 2.6). Small pens should be avoided and places to hide provided.

2.3 Size of pens and stocking density

The minimum area for a floor pen should be sufficient for each animal to carry out its normal behaviour, particularly a wide range of normal locomotory behaviours. A number of organizations have recommended minimum areas per rabbit based on the weight and size of individual animals. These are compared in Table 1. Only the Home Office gives figures specifically for group housing and single caging.

The use of weight and size of animals as a means of determining floor area is unsatisfactory, since it can be argued that younger rabbits need more room in which to play to ensure their normal physical (and psychological?) development. This is precisely the reverse of what is currently recommended. It is interesting to note that recent Swiss legislation (1991) allows every rabbit the opportunity to hop some steps or to jump up and down onto a ledge in order to "train their condition" (presumably to maintain a level of fitness and reduce the occurrence of disuse osteoporosis).

Whatever their weight or age we recommend rabbits kept in groups have a clear area

of around 20,000 sq. cm in each pen to ensure that they are provided with space for activities such as hopping. This would be, therefore, the minimum pen size. It is important to maximize the structural complexity of the pens so that nervous or frightened animals have a bolt hole (see Section 2.6) and, therefore, further space would be required to allow for objects such as boxes and pipes for environmental enrichment; the third dimension could be usefully employed. We recommend an overall minimum floor area of 6000-8000 sq. cm per rabbit for groups of up to 6 rabbits. For numbers in excess of 6, space should be allocated at approximately 2500 sq. cm per rabbit.

It is likely that, in practice, in research establishments animals will be group housed in existing animal rooms which will vary in size. A room of 10 ft x 10 ft (9 sq. m) could house a maximum of 15 rabbits; a dog pen of 3 ft x 6 ft (2 sq. m) could accommodate a maximum of 3 rabbits. In these situations adjustable partitioning to allow for different group numbers would be useful and this is now commercially available.

A maximum group size of between 6-8 mature animals is recommended, so that they can be adequately monitored for signs of bullying and ill-health.

Table 1. Minimum floor area (sq.cm) for rabbits recommended by various authorities abstracted for the purpose of comparison

<i>Weight/age range*</i> (kg) (weeks)		<i>HO</i>		<i>MAFF</i>	<i>CE/EC</i>	<i>RS/UFAW</i>	<i>LABA</i>	<i>SOAP</i>
		<i>s</i>	<i>g</i>	s/g	s/g	s/g	s/g	s
0-5	5 to 12	2000	1300	700	1100	2000	2000	3400
1	8 to maturity	2000	1300	700	1400	2000	2000	3400
2	14 to maturity	2000	2600	1800	2000	2000	2000	4800
3	18 to maturity	4000	2600	1800	2500	4000	2000	4800
4	22 to maturity	4000	3300	1800	3000	4000	4000	7200
5	24 to maturity	5400	3300	1800	5400	5400	7200	7200
6+	28 to maturity	6000	4000	1800	-	6000	5400	9300

*Weight and maturity will vary according to strain.

s=singly housed, g=group housed.

HO Home Office Code of Practice for the Housing and Care of Animals in Scientific Procedures.

MAFF Codes of Recommendations for the Welfare of Livestock - Rabbits.

CE/EC Directive 86/609 EEC regarding the Protection of Animals used for Experimental and other Scientific Purposes. Annex II.

RS/UFAW Royal Society/Universities Federation for Animal Welfare Guidelines on the Care of laboratory Animals and their use for Scientific Purposes.

LABA Guidelines on the care and use of Animals bred for Scientific Purposes.

SOAP Swiss Order on Animal Protection 1981, Revision 1991.

2.3.2 Height of pens

The height of the pen is important since rabbits are able to jump surprisingly high.

Enrichment objects must be carefully positioned as they can provide for 'lift-off'.

The minimum height will depend on the breed of rabbit; 1-25 metres is suggested.

2.4 Establishing groups

Ideally, rabbits for group housing should be female and as young as possible. They should be

mixed at weaning, if possible keeping them as groups of litter mates of the same sex. Establishing groups in other circumstances can be done, but will require more care. For example, there may be problems if rabbits are left for too long after weaning, especially once sexual maturity is reached. It may also be difficult to pen animals that have been caged individually, for long periods of time (e.g. several months), and to mix rabbits from separate groups which have become too small to maintain alone. A variable pen size system will solve the latter problem and reduce the wastage of space. Care will also be required when an animal is removed to carry out a scientific procedure and then re-introduced back into the group.

Sections 2.4.1 to 2.4.4 below set out the best ways of forming groups and overcoming the problems mentioned above.

2.4.1 Initial grouping

Generally, the younger the animals are, the better. Weaning and mixing at 6 weeks in groups of up to 6-10 has proved very satisfactory, although smaller groups may be more stable (see also Love & Hammond, 1991). Animals should be of the same sex if they are to be maintained in the group for longer than 2-3 months. Separate litters of similar age can be grouped, although it is probably wiser to mix these as little as possible.

Some animals do not appear to settle well in groups. They may be too dominant and bully the others, or too timid and prone to being bullied. The bully can be removed (see Section 2.1) but the next rabbit down the hierarchy may then begin bullying. If so, other ways of reducing fighting may have to be tried (see below). When bullying does break out - and it can do so for no apparent reason in what appears to be a stable group - animals must be monitored closely for injuries (particularly of the testes if these are descended) until the group settles down again. The cause should be identified and removed and a variety of husbandry methods used to overcome the problem (see Section 2.4.4).

2.4.2 Group housing previously caged rabbits

When mixing rabbits that have been caged for six months or more, it may be very difficult to avoid fighting or self-inflicted injuries. The animals may initially be frightened of the new space, noises, smells or other animals. Furthermore, because of the weakening of the bones (Lehmann, 1989) and the lack of coordination resulting from long-term confined caging, these animals will be more prone to injuries such as fractures. However, the experience of the Working Party members in mixing previously caged animals is limited, and these statements are not intended to dissuade others from trying. Does that have spent more than 12 months in a cage have adapted successfully to group housing (Morton & Gunn, pers.comm.). We believe, that given a high standard of stockmanship, the benefits derived from success far outweigh the harms that may result.

Take great care when group housing previously, caged rabbits.

2.4.3 Re-introduction after removal, for example to carry out a scientific procedure

Care must be taken when returning an animal to its group after removal, for example, to carry out a scientific procedure.

It has been common practice when established groups were temporarily broken up, to separate all the animals and then to put them all back together. Alternatively, a separated

animal was kept in a cage on the floor within the pen until fit to be with the others again. However, it has been found that these precautions are not always necessary. The removal of animals for surgery and their subsequent replacement back in the pen after complete recovery from anaesthesia has presented no problems. Mutual sniffing occurs, but presumably the pen smell is still apparent and is not masked by other odors such as halothane.

Another situation where animals may need to be regrouped is when a proportion of the rabbits in separate pens are used, leaving smaller, similar sized groups which could subsequently be mixed together. It is important to place the rabbits into a fresh neutral area to avoid home territory for any one group. If wire partitions are used to separate individual pens these provide for a degree of familiarization between animals before mixing. The rabbits may still show aggressive behaviour, which may last from several hours to several days during the establishment of a new hierarchy. After this time the animals appear to settle down and form a stable group. In any event, they must be carefully monitored and, at worst, the groups may have to remain separated. The use of sedatives prior to mixing has been found to be very successful (Love & Hammond, 1991), although other methods should be tried first.

2.4.4 Methods to avoid bullying and aggression when establishing groups or regrouping rabbits

The following husbandry methods can be used to avoid problems with bullying or aggression when mixing rabbits for group housing. They are given in order of preference:

- (a) provide the animals with hiding places (Fig. 2) and break up the clear areas so they minimize damage to themselves (see section 2.6);
- (b) scatter faecal pellets and urine soaked litter from each rabbit in the pen when the rabbits are mixed;
- (c) scatter food in the pen to encourage time-consuming foraging;
- (d) provide for visual contact through wire mesh divides before removing these and allowing groups to mix;
- (e) mix the animals in a pen area neutral to all animals concerned;
- (f) have their usual handler handle them together in small groups prior to mixing;
- (g) anaesthetize or heavily sedate them and mix them together before regrouping (Hammond & Love, 1989);
- (h) castrate males or females.

2.5 General husbandry

Two of the factors which influence rabbit husbandry and which need particular consideration are the animals' senses of smell and hearing.

The sense of smell may be very important in rabbit husbandry since complex information concerning social interactions relating to sex, hierarchy and mother/infant relationships is communicated via the olfactory environment (Bell, 1986). Mykytowycz et al. (1976) have demonstrated that surrounding a rabbit with its own odour increases its confidence. Other experiments have shown that a rabbit will choose straw or shredded paper as a floor surface in preference to wood shavings - possibly because of the strong

pine/softwood type smell of the latter (Tumer *et al.*, 1992; Sainsbury *et al.*, in prep., 1993).

It can be reasoned that, since the opportunity for social communication is restricted in singly housed rabbits, then the effect of odour for individuals in this situation may be exaggerated. In comparison, group housed rabbits may have a more natural social interaction and may be subjected to less rigorous cleaning regimens, thus producing a stronger olfactory field. Other potentially disturbing odours (e.g. from bedding) are less likely to affect the animals in this situation.

Particular care should be taken to avoid using strong smelling substrates such as shavings or sawdust. Straw is the preferred material in terms of minimizing olfactory field disturbance. Care must also be taken in determining an appropriate cleaning regimen. A balance must be struck between the comfort of humans and their perception of necessary cleanliness, and the level of disturbance to the rabbit. Partial cleaning of a pen or cage, and a continual turnover of bedding is preferable to a total clean out, though the latter will be required every 2 weeks. Strong smelling cleaning agents should also be avoided and handlers should avoid strong perfumes/ aftershaves. It should also be kept in mind that the smell of a previously handled rabbit on clothing may be strong and cause adverse effects, especially when nervous rabbits are handled subsequently.

These general recommendations may be more critical at times when a rabbit is particularly sensitive to odour, e.g. in the pregnant or postpartum doe, or when hierarchies are being established.

Rabbits are able to detect sounds inaudible to humans (ultrasound). They are particularly sensitive to sounds between 2-16 kHz and can detect noise up to 42 kHz (Fay, 1988). Ultrasound has been detected from common laboratory equipment such as temperature regulating devices, cage cleaning equipment, vacuum hoses and even running water. Using such equipment may disturb or distress rabbits and due consideration should be given to this. Provision of background noise from a radio may mitigate effect of ultrasound these sources, but may in itself be stressful, particularly if played at high volume.

2.5.1 Bedding

Pens should have an easy to clean non-slip floor, with a substrate of reasonable depth to ensure a clean, dry lying area (Fig. 3). A depth of 2 cm of sawdust or newspaper is suggested, though most of the Working Party preferred a 5 cm depth of straw. The shallower the depth of bedding the more frequently the pens have to be cleaned out. Two weeks should be considered the longest acceptable interval between complete changes of bedding.

Several factors should be considered when choosing bedding. It should be non-toxic and comfortable for the animal. Its smell is also important, as some hardwoods or woods from evergreen trees contain resinous aromatic oils which affect the animals' behaviour patterns by altering the olfactory field. The bedding should be absorbent and not create a health hazard to staff or animals, e.g. through being dusty, or having high pesticide or herbicide residues.

The bedding materials currently available include:

Straw: This may be used chopped or natural. Barley straw is preferable to wheat. Straw has the advantage of providing environmental enrichment (for playing, manipulating, eating, burrowing) as well as bedding. Ideally, it should be sterilized by autoclaving before use

though, in practice, associated diseases do not seem to have been a problem.

Sawdust: This should be made from nonresinated (softwood) timber, should not smell strongly and should be dust-free. Autoclaving may remove odours that offend animals. Sawdust is absorbent, though some types of hardwood may not be sufficiently so to avoid accumulation of high ammonia levels. It can be used with straw, but is scattered freely by the animals and may add little advantage to the use of straw alone. Some of the coloured hardwoods can stain fur.

Shavings. There is some evidence that rabbits avoid shavings, such that in cages they will choose a grid floor in preference to a bedding of wood shavings. Shavings should be from nonresinated timber, should not smell strongly and should be dust free. Some types of hardwood shavings may not be sufficiently absorbent to avoid the accumulation of high ammonia levels.

Paper: Shredded computer paper is available in increasingly large amounts and it provides a clean, dust-free and odourless substrate. Rabbits seem to find it as acceptable as straw (Fig. 4). Its main disadvantage is its lack of absorbency, though this can be overcome by combining it with newspaper (which can also be used alone). Shredded paper can also be used as a substrate under straw.

Hay, bark, peat, coconut fibre, cat litter, ground maize cobs and sand have also been used as bedding materials, but would seem to hold little advantage over straw and are likely to be more expensive.

Preference tests carried out by members of the Working Party have shown that rabbits prefer straw or shredded paper and avoid sawdust or shavings (Turner *et al*, 1992).

2.5.2 Pen cleaning

Each animal facility will need to determine its own appropriate cleaning regimen. Pens should be cleaned sufficiently often to stop the accumulation of dirt. Intervals between cleaning will depend on the stocking densities used. Overfrequent cleaning and disinfection may do more to disturb the rabbits and their all-important odour environment.

The tendency for wild rabbits to defecate/ urinate at preferred latrine sites is also seen in domesticated rabbits, which will often use a preferred corner for excretion. This may facilitate pen cleaning: however in practice, although urine does tend to accumulate in one corner, some faecal pellets are spread around by the animals' scampering movements or dropped away from latrine areas whilst feeding. Any latrine areas should be cleaned at least twice a week.

The pen and room will require a complete clean every time a room is cleared and new stock brought in. The floor should be hosed down and an odourless disinfectant used. Otherwise pens may be brushed (and hosed) every two weeks. Descaling may also help keep pens clean (Love & Hammond, 1991).

2.5.3 Food

Rabbits are generally fed a nutritionally adequate standard pelleted diet *ad nauseam*, but this

can lead to obesity when they are singly housed in cages. Obesity may not occur in group penned animals due to the greater opportunity for exercise. Furthermore, since it is possible that overeating is a stereotyped behaviour, the environmental enrichment in group housing systems may reduce this behaviour.

Dried pelleted food should be given at the rate of around 60-80g/kg body weight/day, depending on age and other factors, such as the exercise area available and the activity of the animals. To relieve the boredom of this diet more than one formulation could be used. This might appear to introduce an unnecessary variable into experiments, but unless the diet is totally synthetic, there could be just as much variation in nutrients between batches of the same diet.

In addition to the standard pellets, rabbits can be fed on diets which provide a range of alternative textures and tastes, such as flaked maize, barley, oats, peas and soya, all of which can be purchased as mixtures. More natural foods such as cabbages, carrots, parsnips, turnips, marigolds, dandelion leaves, apples and hydroponic grass, can also be fed (Lehmann, 1989). With all diet variations, nutritional adequacy must be ensured. The vegetables must be cleaned to avoid the risk of introducing disease into the animal house. Washing them in clean running water and discarding the outside leaves considerably reduces the risk of contamination and in the experience of the members of Working Party no diseases have been incurred using these precautions.

Hay is an important food as it has a dual value, being nutritional and providing something to play with. It should be sweet-smelling, soft but fibrous and free from dust. Good quality bales of hay are usually light in weight. We recommend that hay is fed to rabbits daily. It may be safer to autoclave it as there is a small risk that infections and infestations may be transmitted, although the members of the Working Party have not experienced any such problems. Autoclaving will reduce the vitamin C content to virtually nil. Nevertheless, the hay will retain the benefits of providing fibre for the animals and giving them something to chew, and it may make it more palatable.

Scattering food is considered important as it reduces boredom by encouraging the animals to forage. This reduces the amount of time available for fighting and helps keep the rabbits from becoming obese. Food can be scattered or placed in small piles around the pen in order to avoid dominant animals preventing others from approaching the food trough. Fouled or uneaten food must be removed from the pen daily.

At times when animals are stressed (e.g. through transport or at weaning) they are more likely to develop disease, particularly diarrhoea and snuffles, and it is advisable to minimize other changes which might predispose them to these troubles. Using the same food as the supplier and changing to the new diet gradually over a period of time to three weeks can help.

2.5.4 Water

A plentiful supply of clean water should always be available. The use of chicken water hoppers (Fig. 5) placed on top of breeze blocks helps prevent the water being contaminated with sawdust and droppings. Automatic watering systems and water bottles are also recommended but care needs to be taken to prevent rabbits playing with them and to avoid leakage and overflows.

All water containers should be kept clean and be sterilized as appropriate.

2.5.5 Good Laboratory Practice requirements

Good Laboratory Practice (GLP) may set rigid requirements for laboratory animal care which may prohibit provision of bedding, a varied diet, or objects within the cage. In some instances, this can severely limit opportunities for enriching the animals' environment. It is important to critically review GLP requirements to determine whether the limitations they set are really essential for achieving satisfactory test results.

2.6 Environmental enrichment

It is particularly important to enrich the environment and give the animals something to do. Some ideas have already been given regarding diet and feeding. It is important for individual rabbits to be able to get away from each other and be able to hide. Provision of boxes, paper sacks (e.g. sawdust bags), dustbins and wide-bore plastic pipes (drainage pipes) fulfil such requirements. Boxes can be purpose built or improvised from, for example, cardboard boxes. It is probably best to provide one box per rabbit - they may all get into one box, but individuals have the option to use another box if they wish.

Rabbits are used to running underground to hide and also seem to like to have an elevated view. Floor pens are very open and it is recommended that shelves or planks be provided for them to hide under or to climb on. Shelves get dirty quickly and so require frequent cleaning. They must be positioned carefully so that they do not facilitate escape. Researchers in Switzerland (Lehmann, 1989; Ritter, 1989; Stauffacher, 1989) have designed rabbit accommodation on two levels which incorporates hiding and resting places and allows easy capture. More frequent cleaning is required than for a flat pen, though no more than for an ordinary cage.

Straw for bedding and hay in the diet have the additional advantage of providing environmental enrichment. Branches placed in the pen also have a multiple purpose, providing something to gnaw, to chin-mark and to climb on.

To provide fresh stimuli for animals, objects (and therefore, the scents of other animals) can be rotated between pens as an alternative to trying new objects to relieve boredom. These should be cleaned occasionally and obviously not moved between pens if disease occurs.

Music will provide background noise for the duration of the working day, but whether this counts as environmental enrichment is a matter of debate.

2.7 Catching and handling

Catching animals when they are group housed has not proved to be a problem. If the animals are looked after carefully and receive regular attention from their handlers, then they become familiar with humans as part of their normal environment. They are not frightened and so do not run away. It will obviously take time and effort to achieve this state and it is easier if the animals have been handled regularly from an early age (Denenberg, 1969). Young rabbits are normally easy to handle if the doe is handled first and given interesting food to distract her.

Both penned and caged rabbits can be frightened by sudden noises or movements, which may lead them to injure themselves and other rabbits. Fear is likely to increase levels of some hormones (e.g. catecholamines, corticosteroids) with various physiological

consequences which may in turn affect research results. In pens, frightened rabbits have space to run and, if there is nowhere to escape, they will simply keep running aimlessly for several seconds during which time they can damage themselves. Temporarily breaking up the pen area with solid walls and providing hideaways prevents this.

It is always a good idea to let animals know that you are approaching, for example by making some routine noise before entering a room. Background music can mitigate the effect of extraneous noises.

Correct restraint, handling and lifting techniques should always be employed (Figs 6A-D). This assumes an even greater importance in a group housing system where poor handling techniques may result in serious injury. A firm but reassuring attitude should be adopted and the animals picked up by the scruff, supported under the hind legs and carried with the rabbit's head hidden under the handler's arm (see IAT video).

2.8 Identification

It is important to be able easily to identify individual group housed animals from a distance. Ideally the method used should not be painful, not cause an adverse reaction (e.g. chronic granuloma or keloid), not be uncomfortable and not be likely to catch or tear out. The following methods have been used, ranked in order of preference.

Coat colour and pattern: useful when there are mixed strains or individuals in small groups.
Wool dyes: these must be permanent and have to be renewed as the animal moults because the dye fades. Agricultural sheep sprays may be used and these last 5 to 6 weeks.

Felt Pen marking of ear: can be used on the outside of the ear but has to be renewed each week. Additional marks on the back allow recognition at a distance. Felt pen can cause a dermatitis if animals are kept for long periods. Xylene-free permanent markers may be better. These are less toxic and will last 3 weeks.

Microchips/transponders: these can be inserted at 6 weeks of age. There may be some pain on insertion. The initial investment is expensive since a reader is needed. The transponders can be removed and re-used.

Leg rings: these can be open or closed and are usually made from aluminium, although plastic ones are available. They are fitted over the hock at about 6 weeks of age. They can be a source of irritation and have to be checked at weekly intervals during the growing period to ensure they do not become too tight.

Fur clipping: fur grows quickly so has to be carried out frequently.

Ear tattoos: commonly used, but cause some discomfort at the time of tattooing, especially if carried out without sedation or anaesthesia. The tattoo gun also produces high frequency sounds and can be disturbing to the animal. Tattoos can be difficult to read on pigmented skin.

Studs or ear tags: can cause problems because they may get lost, cause infections leading to the growth of fibrous tissue as a chronic inflammatory response, and be painful to insert.

Collars: these may be chewed off by other rabbits, may drop off, and animals may catch their legs in them-not recommended.

Wool dyes, felt pens and microchips are recommended. For experimental work, it is prudent to use 2 methods of marking animals.

2.9 Breeding

There are advantages to breeding animals for subsequent group housing 'in-house' (see Section 2.2) and Stauffacher (1989, 1991, 1992) has recently published an interesting description of practical group breeding systems. Consideration has to be given to the best strain of rabbit to use in research, but it is also important to select the best individuals for use in a breeding programme, since there is some evidence that aggressive behaviour is genetically determined (Kraft, 1979). Also see comments in Section 2.2. 1, paragraph 2.

It is important to select animals for their docility and ease of handling, and for being neither too dominant nor too fearful of other animals. A high reproductive index and growth rate might be desirable from the point of view of the breeder, but care should be taken as this may not be in the best interests of the animals or the science.

A ratio of between 2 and 5 females to one buck has been found to be acceptable. Once the male has mated he can be removed. One box per female should be provided so that each doe has the option of nesting alone, as is most typically the case. Rabbits have also been successfully bred in groups with one buck and two females sharing the same pen. It is the does rather than the buck that are likely to kill the pups and the females must have been reared together for this method to be successful.

Breeding systems must be easy to manage and must allow for easy monitoring of the animals, including the pups. In the wild, females make nests but practice absentee parental care, only visiting the nest for perhaps 5-10 minutes a day to suckle the pups. In floor pens, nest boxes can easily be provided. They can be wooden, or constructed from a few bricks, and ideally should be provided 2 weeks prior to littering, with 5 days as a minimum period. A nest box 38 x 25 cm and 20 cm deep appears to work, especially if sunk into the floor and the doe can see into it. The size will depend on the strain of rabbit since the litter size is smaller in some than others. (Note: if the box is too large the doe will tend to urinate in it.) Hay should be placed both in the nest box and elsewhere so that she can perform full nesting sequences.

It is common practice to examine the young on the day of birth and, if necessary, to reduce the number to between 8-10 per doe. The young emerge from the nest box at about 2-3 weeks of age and can be weaned at 4 to 6 weeks, depending on the size of the litter. They can be divided into single sex groups of about 5 animals. Such weaning groups have been found

to be stable for considerable periods (see Section 2.2.3). The group size depends partly on local custom but, if the animals are too crowded, the growth rate of some will fall.

Post-partum mating can be carried out, but the doe should be in a suitable condition to be able to sustain the pregnancy without jeopardizing her health. Mating a week or two after weaning is preferable for most animals. Breeding females should always be examined to ensure that they are in good health before mating. They should be checked from head to tail in a routine manner for problems with, for example, teeth and mastitis.

Domestic rabbits can live for 10-12 years. Depending on the strain of rabbit, a breeding doe in captivity could provide 40 young per year (5 litters of 8, or 4 litters of 10). The litter size tends to decrease in the second year, perhaps because of the high demand on the animals. It is commonly observed that productivity takes a dip in the late autumn-early winter period, even when environmental conditions such as light and temperature are carefully controlled; it has been found helpful to use a young buck for breeding at this time.

2.10 Health

Love and Hammond (1991 and pers. comm.) kept rabbits in penned conditions over a period of 3 years with between 100-180 animals penned at any one time; this is equivalent to 141,000 rabbit days. They found that there were only 124 incidents of treatment required during that time. Severe disease problems were minimal and usually related back to the supplier. The commonest problems necessitating treatment were from fighting (41%); abscesses (12%); pneumonia (8%); snuffles (4%); alopecia (70%) or sore hocks (7%). Middle ear disease, conjunctivitis, mucoid enteritis, dewlap dermatitis, coccidiosis, ear mites, malformation, ulceration of tongue or stomach and uterine bleeding were all lower than 3.2%.

Adult rabbits can sometimes damage each other whilst fighting though the wounds are rarely fatal (Love & Hammond, 1991). The injuries associated with fighting include, at worst, broken vertebrae (particularly the processes) and other bones. This occurs more commonly in animals that have been previously caged and have osteopenia. Superficial skin lacerations, particularly over the eyelids, the nape and back, due to mounting and fur pulling, are not uncommon. Deeper wounds in the underbelly, particularly on the scrotum, may necessitate the animal being stitched and castrated. Underbelly wounds, particularly around the testes, are common and rabbits should be regularly checked for these since such wounds are not easy to see

without handling the animals.

In a stable group, injuries are few and far between-at the most, minor skin abrasions which can be treated with an antiseptic wound dressing powder. Many heal of their own accord. Occasionally, an abscess will form and will need to be lanced, bathed and dressed for a few days. The pus is normally a white, thick, caseous material which may be resistant to antibiotics. Topical treatments provide the best approach to this problem.

Increased health problems associated with group housing, apart from fighting injuries, have not been reported (Love & Hammond, 1991). In fact the incidence of snuffles (rhinitis and sinusitis) may be reduced, possibly because the better ventilation ensures the rabbits are not exposed to such high urinary ammonia concentrations (and other volatile chemicals) as they are in solid-walled cages. However, animals kept in groups that are not stable may suffer from stress. They may, for example, be bullied and prevented from eating and drinking

regularly. With good husbandry-regular monitoring and weighing of animals - such cases should be detected early. A weekly monitoring session also provides the opportunity to check the teeth and claws for overgrowth, the ears for canker, and for abscesses.

Diarrhoea can occur in penned rabbits just as with animals in cages. It is traditionally associated with coccidiosis. However, care must be taken in making this diagnosis since the presence of oocysts does not establish coccidiosis as the cause of diarrhoea; it can simply be an opportunistic infection, secondary to any gut disorder. Outbreaks of primary coccidiosis have not been commonly observed in many grouped animals are not even fed a coccidiostat supplement feed because of its potential effects on research. Presumably, the combination of good husbandry and low stress enables an immunity to develop and this is sufficient to overcome the problem. Love and Hammond (1991) found the occurrence of diarrhoea to be associated with the stress of transport (usually in the first week). As with any other disease, veterinary advice must be sought to determine the cause and provide treatment.

It is important to be particularly alert to the possibility of disease outbreaks when new groups are brought into a rabbit facility since the newcomers will be stressed, and they and the existing residents could become exposed to novel pathogens (see last paragraph of Section 2.5.3).

If an infection does occur then there is concern that it may spread more easily in group-housing systems than when animals are housed singly. However, this logic is not applied to other small mammals such as rats and mice. There is no difference in this regard between keeping groups of mice in cages and keeping rabbits together in pens. Unless animal technicians and scientists exercise extreme care going between singly-caged rabbits and unless the ventilation is carefully controlled and directed, the spread of infection could occur equally under single-housed or group-penned systems.

Inspection of health records kept by members of the Working Party have not shown any major differences between group housed rabbits and caged rabbits, nor between animals fed cabbage and carrots compared with those kept on a conventional standard diet.

2.11 Running costs

The cost of running a group housing system depends on the type of system employed (which in turn depends on the type of research work) and the level of labour involved. The use of group pens as opposed to cages, will produce savings in terms of cleaning and the associated labour and in bedding materials. This is particularly so if straw is used, since this is cheaper than sawdust. There will be savings in terms of energy, maintenance and servicing of cage washers as well as in chemicals (descalers, disinfectants). Staff time may also be saved since group housed animals take less time (up to 50%) to clean out. However, some of the time saved will need to be spent watching, checking and handling the animals, and familiarizing them with the scientific procedures involved.

Compared with a caging system, the running costs of group housing should not be excessive because:

- * the stocking density in group housing can be the same, if not greater;
- * with a restricted diet programme, diet wastage is less and therefore economical;
- * bedding costs are considerably reduced.

Members of the Working Party carried out the following exercise comparing the costs of bedding for 120 rabbits, housed in groups of 6 to 9, and 120 housed singly in cages. (Staffing and overheads were not assessed.)

The group housed rabbits were cleaned out once per week. Cage trays of caged rabbits were cleaned twice and sometimes 3 times per week. Over a year the costs for the pen and cage systems were £864 and £1334 respectively.

<i>Clean out cost per rabbit per week</i>		<i>Cage(0-45sq. m.)</i>	
<i>Group housing (4-5sq.m.)</i>		<i>(cleaned twice)</i>	
<i>(cleaned once)</i>			
Wood chips	Barley straw		Tray
(12.2 p)	(1-7 p)		21.4
	13-9p		

The use of barley straw alone allowed a further significant reduction in costs to 1.7 p per rabbit.

Although not part of financial considerations, the environment and interactions of group housed rabbits provide for a far more aesthetic and pleasant situation for animal technicians and scientists to work in.

2.12 Advantages and disadvantages of group-housing rabbits

2.12.1 Advantages

1. *Physical health improved:* animals have a larger area to explore, move and play in, which will help ensure and maintain normal physical development; claws will not need clipping, as often and osteopenias, e.g. osteoporosis, are avoided.
2. *Psychological well-being improved:* animals have room to carry out natural behaviour patterns and there is a reduction in unnatural behaviour patterns; the animals appear to be less bored.
3. *Social interaction is available:* there is greater opportunity for social interaction and behaviours such as play.
4. *Allows broader range of natural behaviours to be expressed:* e.g. there is greater opportunity for environmental enrichment to permit territorial behaviour.
5. *More docile animals:* the animals may be less timid and more tractable due to regular exposure to humans, other animals, and a larger environment.
6. *Meets the spirit as well as the letter of the HO Code of Practice:* e.g. in regard to exercise (see Home Office Code of Practice 1989-Section 3.38).
7. *Capital outlay less:* cages are more expensive due to complicated designs and maintenance. There will be additional savings on the purchase of racks, hoppers and water bottles.
8. *Economic advantages:* a group-housing system costs less in terms of bedding, cleaning agents, maintenance, energy and labour.
9. *Overall space utilization:* little or no space is wasted as occurs between racks of cages, but there is less utilization of height.
10. *Less air pollution:* air circulation is better than in solid-walled cages.
11. *Greater job satisfaction:* for the animal technicians and scientific staff.
12. *Some diseases may be reduced:* e.g. snuffles.

2.12.2 Disadvantages

1. *Fighting*: there may well be problems with aggressive or submissive animals, leading to more injuries which may require veterinary attention. This may necessitate extra space for the isolation of sick or dominant animals.
2. *More scientific variables*: the environment of group housed rabbits is less controlled for individual animals and so, on some occasions, it may not satisfy scientific requirements. This has to be balanced against animals being more 'normal', physiologically and psychologically.
3. *Occasional instability of groupings*: the composition of the group may be disturbed if a particular animal is removed or separated even for a short period of time. There can be difficulties in reintroducing such an animal into the group. Furthermore, stable groups can suddenly become unstable for no obvious reason.
4. *Treatment of disease*: this may be more difficult since removing an animal to treat it may disrupt the group.
5. *Stress*: there may be a problem with aggression leading to animal distress and for example a consequent reduction in immuno-competence.
6. *Difficulties in rehousing previously caged animals*: due to osteoporosis and their lack of social experience.
7. *Identification*: of animals may be more difficult.
8. *Stockmanship*: technicians need to be trained in recognizing all the different elements of rabbits' behaviour.
9. *Security*: pens have to be made secure to prevent the escape of animals.
10. *Pen design*: can be more difficult due to the shape of rooms and available space. Height space is often wasted, though good design can utilize height more effectively, e.g. shelving.
11. *Monitoring*: of individual animals in terms of food and water intake and external secretions is more difficult. Good stockmanship is required and closer attention to (or isolation of) animals that give rise to concern.
12. *Waste disposal*: may cause a problem because of its volume.
13. *Disturbance of substrate*: increased disturbance of substrate will shorten the life of air filters and may increase the risk of laboratory animal allergy to staff.

Table 2. MAFF recommendations for minimum floor area per rabbit (Code of Recommendations for the Welfare of Livestock)

<i>Age of rabbit</i>	<i>Minimum floor space (sq. cm)</i>	
	<i>In cages</i>	<i>In hutches</i>
Doe and litter to 5 weeks of age	5600 total area	7500 total area
Doe and litter to 8 weeks of age	7500 total area	9300 total area
Rabbits 5 to 12 weeks of age	700 per rabbit	900 total area
Rabbits 12 weeks and over (other than those used for breeding) (multiple occupation cages)	1800 per rabbit	
Adult does and bucks for breeding	5600 per rabbit	7500 per rabbit

3 CAGED RABBITS

3.1 Introduction

Caging of animals individually should not be a method resorted to by default. Rabbits should only be housed singly in cages where penning of animals in groups is inappropriate, e.g. when there is a strong scientific reason for doing so, or if animals need to be isolated for their own welfare. When cages are used, group housing (e.g. in compatible pairs) in cages should be considered (Fig. 7). The largest possible cage size should be used (cages can be linked together) and the cage environment should be enriched.

Some strains of rabbit have been selectively bred and are more suitable for caging in laboratory conditions.

3.2 Cage design-size

Rabbits must have sufficient room to allow free movement and a wide range of natural ambulatory behaviours so that their normal bone and muscular development can occur (Lelimann, 1989), otherwise problems with osteoporosis and other skeletal abnormalities arise (Stauffacher, 1991).

The size of the cage will of course depend on the strain and size of rabbit kept. Various authorities have laid down guidelines of recommendations in this regard, and these are given in Tables 2-4. The minimum floor area recommended increases with the size/weight of the rabbits. However, the relationship between body weight, cage size and behavioural needs has not been established, and any system based on such a relationship may be fundamentally flawed. One factor that does not seem to have been addressed is that, in general, young animals tend to be more active than older animals, yet paradoxically, in current guidelines, the bigger (i.e. the older) the animal the more space is recommended. This allows animals to stretch out, but makes no allowance whatsoever for movement. The recommendations should be changed accordingly. However, it should be noted that even the larger cage sizes will *still* not enable younger and more active rabbits to fulfil much of their behavioural repertoire. A further consideration is the actual usable floor space in these cages. The area under and around the food hopper and water bottle and spout can restrict exercise or stretching out.

It is recommended that the usable cage space provided for young animals be increased immediately to the largest cage sizes as defined for larger animals.

Table 3. Home Office recommendations for minimum floor area per rabbit (Code of Practice for the Housing and Care of Animals used in Scientific Procedures)

Weight of rabbit	<i>Minimum floor area sq. cm per animal</i>	
	Housed singly	In groups
Up to 2000g	2000	1300
2000 to 4000g	4000	2600
4000 to 6000g	5400	3300
Over 6000g	6000	4000

The working party considered these recommendations to be minimum requirements.

Table 4. Recommended minimum cage heights (in cm)

<i>Weight/age range</i>		<i>HO</i>	<i>MAFF</i>	<i>CE/EC</i>	<i>RS/UFAW</i>	<i>LABA</i>	<i>SOAP</i>
<i>(kg)</i>	<i>(weeks)</i>						
0-5	5 to 12	40	45	30	40	40	40
1	8 to maturity	40	45	30	40	40	40
2	14 to maturity	40	45	30	40	40	50
3	18 to maturity	45	45	35	45	40	50
4	22 to maturity	45	45	40	45	45	60
5	24 to maturity	45	45	40	45	45	60
6+	28 to maturity	45	45		45	45	60

HO Home Office Code of Practice for the Housing and Care of Animals in Scientific Procedures.

MAFF Codes of Recommendations for the Welfare of Livestock - Rabbits.

CE/EC Directive 86/69 EEC regarding the Protection of Animals used for Experimental and other Scientific Purposes. Annex 11.

RS/UFAW Royal Society/Universities Federation for Animal Welfare Guidelines on the Care of Laboratory Animals and their Use for Scientific Purposes.

LABA Guidelines on the Care and Use of Animals bred for Scientific Purposes.

SOAP Swiss Order on Animal Protection 1981, Revision 1991.

A useful method for defining cage space is in terms of stretch factors as defined by Eveleigh, 1988. Eveleigh rightly noted that rabbits like to lie out fully stretched (toe to toe extended). He then found, by measuring animals after death, that body weight was not an accurate guide to body length. He therefore analysed cages from the latter perspective. Thus, cages allowing the rabbit to stretch full length diagonally are described as having a stretch factor of 4; stretch factor 6 cage permits widthways and diagonal stretching; and a stretch factor 8 cage enables the rabbit to stretch fully along the length, width and diagonal, i.e. all the way round.

The largest cage manufactured should be bought, and stretch factor 8 cages are obviously to be recommended. Unfortunately, these may be too deep to permit easy catching of the rabbit and for the technician to handle for cleaning. In this case a stretch factor 6 cage should be considered as the minimum size. It should also be remembered that stretching out is only one of the rabbit's repertoire of behaviours. For example, rabbits like to sit on a shelf

or on top of the nesting box. The provision of a shelf thus adds to the available area and provides a form of enrichment. For breeding females the recently available bolt-on nest boxes (Fig. 8) provide a suitable nesting area without decreasing the overall size of the cage.

Cage height: The height of the cage is also important since in the wild much of a rabbit's time is spent sitting upright on its hindlegs with ears pricked (lookout position) and sitting on its hindlegs with its front paws on the ground (sitting position). The minimum height recommended in current guidelines is 45 cm (MAFF, 1990) (see Table 5). MAFF states that the cage should be of sufficient height to allow the rabbit to 'sit upright on all four feet' (i.e. sitting position) without their ears touching the top of the hutch or cage (Statutory Instrument 1990 No. 1445). The required height will depend on the size of the rabbit. A suitable height to allow a New Zealand White, for example, to perform typical lookout behaviour is 75 cm. In practical terms it would be difficult to make and use such large cages.

3.3 Cage material and floors

Traditionally, rabbits have been housed in wire or metal cages on grid floors. Different types of flooring are now available as well as plastic cages. Certain types of cage flooring (e.g. grids) are linked to the occurrence of sore hocks (pododermatitis), a health problem associated with caged rabbits. The condition is also linked to the frequency of cage cleaning, as well as to the length of time animals are caged. The types of cage floors now available do not seem to predispose rabbits to this condition, the dimpled patterns are apparently preferable. Breeders have also selected strains that are more resistant to developing sore hocks, or have eliminated the problem altogether by selective breeding. On all types of cage floor, claw clipping has to be carried out regularly approximately every one to 2 months.

The advantages and disadvantages of different types of cages are discussed below.

Wire cages: wire cages have 2 main advantages: the animals can see all around them and they are quieter than solid metal when animals thump or move rapidly. They may also enable animals to communicate, not only by sight but by odours and urine spraying. The animals can see people approaching and are therefore less jumpy. Wire cages also provide good ventilation. The minimum gauge wire for caging should be 12 gauge with 3-4in/7-10cm mesh.

The disadvantages are that wire, grid floors may be uncomfortable for the animals and there is no darkened area into which the rabbit can withdraw. (This is now a requirement under Swiss law.) Animals can urinate outside the cage and this can create problems for cleaning. Wire can be chewed or may break and subsequently cause injuries and infections and is also difficult to clean. However, if the cages are well built and well maintained these problems should not occur.

Metal cages: metal cages, made from galvanized iron, stainless steel or aluminium, are more easily cleaned than wire cages. They can now be fitted with several different types of flooring including grids, dimples, bars and slats. Dimple floors are probably the best for the comfort and health of the animal.

The disadvantage of these cages is that they have solid walls and ceilings, which

isolate the animal inside. Together with the limited area for movement, this makes such cages extremely restrictive from an ethological viewpoint. They are also cold, noisy, heavy and restrict ventilation, as well as being less easy to clean.

Plastic cages: plastic cages have come onto the market more recently. They are larger and the animals seem to lie out more on them, perhaps because plastic may feel warmer than metal. They are less noisy and are therefore likely to cause less disturbances in the animal colony. In general they are easy to clean, although with some designs, where the holes do not go right to the edge, there can be a build up of faeces in the corners. With good husbandry this should not be a problem. Plastic can be autoclaved but the temperature is critical to preserve the cages (see manufacturer's instructions). Disinfection may be an adequate alternative.

Plastic cages may be more difficult to handle because they tend to be larger, though this is partly compensated for by their light weight. The solid walls also tend to make the animals jumpy.

3.4 Substrate and tray liners

Almost all caging systems have trays beneath the grid floor of the cage to catch urine and faeces and facilitate cleaning. The contents of these trays is important because fumes (particularly ammonia) will diffuse upwards and affect the rabbits in the cages. Open-sided cages have an advantage over the traditional solid-walled variety, since the ventilation through the cage is likely to be better. In some situations it is preferable if the rabbits are not in contact with their bedding as this may predispose them to sore hocks and snuffles. (N.B. Animals which actually have sore hocks, however, are better kept on thick bedding such as straw and cleaned out regularly.)

The most commonly used substrate for trays is sawdust (see comments under Section 2.5.1) which should be cleaned out and replenished at least twice if not three times a week. Other commonly used materials placed on trays beneath the cage are:

- (a) corrugated paper;
- (b) paper sprinkled with absorbent powders*;
- (c) preformed cardboard trays. Some of these are sprinkled with absorbent powder. They can then be changed once a week, making cleaning easy;
- (d) absorbent pads. Some forms come in rolls with a plastic backing which can be cut to size. They must, however, fit snugly into the sides and corners of the tray otherwise urine will run down the sides and not be absorbed; their use in practice would not seem to be as good as is claimed;
- (e) winding paper towels-mechanical methods such as this are not recommended (see Section 3.5 below). In rows of cages the faeces and urine of each rabbit will be drawn along under other rabbits' cages. The odours from the excreta may be stressful to other rabbits and many cause reproductive inhibition (Bell & Mitchell, 1984; Bell, 1985, 1986).

3.5 Mechanical flushing systems

Mechanical water flushing systems facilitate cleaning. However, they have several disadvantages: the equipment has to be maintained properly; it is more difficult to monitor the urine and faeces of an individual animal; it reduces contact between humans and the animals and so may alter the user's perception of animals as living beings.

The animal's well-being is very important in laboratory animal science and any mechanical system that takes the emphasis away from human care and interaction with the animal should be discouraged. Whilst the number of technicians can be minimized by such systems it can be counterproductive if the animals are more difficult to handle because they are little used to human contact.

*Absorbent powders absorb smells such as ammonia and particulate matter in the air thus reducing the risk of allergies for staff. However, the powder itself may be odorous and a safety hazard to humans and animals and COSHH assessment will have to be carried out. They must be used with care.

3.6 Food and water

Caged rabbits fed *ad lib* can become obese. It would seem reasonable therefore to restrict their food intake: a rate of 60-80 g/kg body weight/ day depending on age and factors, such as the activity of the animal, has been found to be acceptable.

The use of automatic watering systems and water bottles is recommended. Rabbits tend to play with bottles, so the system should be regularly checked for leaks and blockages.

3.7 Lighting

Lighting requirements for laboratory animals are suggested in the Home Office Code of Practice where a 12 h : 12 h light/dark cycle is specified. However, it may be important to provide a simulated dawn and dusk. This can be provided by the use of either automated dimmer switches or low wattage bulbs that remain on into, or during, the period of darkness. It may be desirable, particularly for albino rabbits, to maintain a lower light level when not working in the room.

3.8 Temperature, relative humidity, ventilation

There are recommended criteria for all these in the Home Office Code of Practice. It should be noted that cages without solid (i.e. wire cages) provide for better ventilation.

Excessive variation in temperature or ventilation rate may predispose animals to developing snuffles.

3.9 Stereotyped behaviour

Rabbits housed singly in cages may perform stereotyped behaviours -described as 'unusual motor acts which are repeated regularly and almost invariably, and which serve no apparent

function' (Kelper, 1969). This seemingly purposeless activity is seen in a large proportion of animals in many isolated and confined husbandry systems. It is still an aspect of behaviour which is poorly understood. It is likely that stereotyped behaviours are a sign of frustration, anxiety, or boredom. Danizer (1986) reported that study of these repetitive actions has been relatively neglected because they do not interfere with normal (agricultural) production as do other categories of abnormal behaviour such as tail biting.

There is very little information available about stereotyped behaviour in rabbits, but the following behaviour patterns have been detected by careful examination of cages and by observing the behaviour of individual animals (Lehmann, 1990; Podberscek *et al.*, 1991; Stauffacher, 1992; Gunn, pers. comm.).

- Rhythmic biting of water bottles and pulling out stoppers;
- Biting, chewing or licking of bars, food hoppers, walls and the grid floor;
- Pawing or digging in the corner and pawing the hopper;
- Excessive fur pulling/chewing/plucking;
- Rapid circling, sometimes including kicking the walls;
- Head swaying/weaving and vertical sliding of nose between bars;
- Pushing and shoving of the water spouts and hoppers with the head;

Rabbits have also been observed sitting in a hunched position for long periods, or sitting with the head lowered in corner.

Stereotyped behaviors may be remnants of escape movements (e.g. circling), a substitute for normal behaviors (e.g. pawing in the corner as a substitute for digging), an alternative to social stimulation (e.g. hair chewing), frustration (e.g. pawing the hopper, tugging the water spout), or simply a mechanism to relieve boredom in a barren, unstimulating environment (e.g. head swaying). It should be emphasized that the majority of the behaviours listed above are only classed as stereotyped when performed excessively.

One of the problems with measuring stereotyped behaviour is the wide range of differences between individual rabbits. When the behaviour of singly-caged rabbits is contrasted with the behaviour of rabbits that are penned in groups, clear differences are evident. Gunn (pers. comm.) compared the behaviour of 18 New Zealand White rabbits which were singly-housed in cages, with 18 New Zealand Whites penned in 2 groups of 9. Rabbits were observed at 5-min intervals over a 24-h period (a total of 288 observations). The number of times each rabbit performed a particular behaviour over this period was recorded. The mean percentage frequency of each particular behaviour is shown in Table 5. Time budgets showed that singly-caged rabbits exhibited increased periods of inactivity compared with grouped animals, with an increased time spent lying down, sometimes in a hunched position and with the head lowered in a corner. They also appear to be more restless showing incomplete patterns of behaviour or movements.

Table 5: The frequencies(%) of specific behaviors observed for 18 individually caged and 18 group-housed New Zealand White rabbits over a 24-h period (Gunn & Morton pers. comm.)

Behavior	Mean frequency of individual behaviors shown by individual rabbits (%)	
	Group housed+	Single caged
Hair chewing	0.20	5.11
Chewing objects	0.23	4.68
Rapid circling	0.24	0.86
Head in corner	0	1.68
Head sway	0	0.32
Hunched position	0.45	2.64
Licking objects	0.10	1.24
Sliding nose	0	3.08
Pawing in corner	0.90	0.37

+Two groups of 9.

When rabbits are cage-housed in pairs of the same sex, mounting both by males and females is seen, as is mutual fur plucking. This behaviour can be reduced by the provision of hay.

Group-housed animals kept on the floor show none of this behaviour in the form of a stereotypy, though pawing and digging in a substrate of shavings have occurred, and enrichment objects such as branches and cardboard boxes were chewed. Only the subordinate animal in a group has been observed sitting hunched in a corner.

3.10 Environmental enrichment for caging

Stereotyped behaviour may be reduced by environmental enrichment and by enabling the animals to interact with their environment. Suggestions for enrichment for caged rabbits are given below.

- (a) give straw which the animals manipulate/ play with by pulling it through their mouths;
- (b) give hay or hay blocks, or hydroponic grass;
- (c) provide pieces of wood or chew sticks (i.e. flavoured wood blocks) to gnaw;
- (d) place a hay rack on the outside of the cage (N.B. hay nets can be chewed through);
- (e) provide small cardboard boxes to play with;
- (f) give more consideration to sociopsychological factors, e.g. occasionally take rabbits out of the cage for handling/petting or for exercise and relief of boredom (see Nerem, 1980);
- (g) the provision of bedding (such as straw, hay) is also important, for comfort particularly for pregnant females;
- (h) Vetbed has also been used for pregnant and nesting does. This is an artificial fibre material which comes in rolls and is often used as an underblanket post-surgery to keep animals warm. It helps satisfy the nesting needs of does and gives them something to do (A. Walker, pers. comm.);
- (i) provision of background noise may be helpful.

It is also important to consider the layout of cages in the room, placing racks opposite to each other rather than side by side allows the rabbits to see each other. (N.B. moving solid cages to a new position is stressful.) Cages without solid walls provide the opportunity for more interaction with other rabbits.

3.11 Advantages and disadvantages of caging

Advantages

1. The food and water intake can be controlled and monitored.
2. Faeces and urine excretion can be monitored and quantified.
3. Animals can be identified without the need to mark them.
4. The spread of infection between animals may be controlled more readily, but not eliminated and only if staff take strict precautions (see Section 2. 1 0).
5. The requirements of those experimental protocols and regulatory authorities that require animals to be singly-caged are satisfied.
6. Easier to maintain a cleaner environment.

Disadvantages

1. When housed singly in solid walled cages the animals are socially isolated. This is detrimental to their psychological wellbeing as they show a greater incidence of abnormal behaviour.
2. There is a limited area and stimulus input.
3. It is difficult to enrich the environment because it is so small.
4. Animals suffer from osteoporosis and other skeletal abnormalities and lose the capacity, for normal locomotion.
5. Constant cleaning and sterilization of cages may disturb the olfactory environment of the animal.
6. Cages are expensive, and time consuming and expensive to clean.
7. In solid cages there are dead spots which reduce ventilation.
8. Lighting may be uneven, making observation of the animal more difficult.
9. It is difficult to monitor health of the animal in terms of its behaviour, e.g. to observe impaired movement due to injury or as a reaction to procedures.

4 CONCLUSIONS

The majority of the members of the Working Party considered that the standard sized laboratory caging currently used for housing rabbits is inadequate to satisfy many of the physiological, behavioural and psychological needs of these animals. In particular, the limited space available can compromise the physical welfare of the animals causing problems such as osteoporosis. Furthermore, the stress associated with such caging can cause physiological changes resulting in experimental artefacts when the animals are used in research. The provision of grouphousing for rabbits, preferably in floor pens, can overcome these problems and significantly improve the physical and psychological welfare of the animals. This should also result in more physiologically 'normal' rabbits which may lead to a reduction in the numbers needed in research.

It was recognized that there are problems associated with group housing systems and that it may not be easy to group house animals, particularly if they have been caged previously and/or they are post-weaning and have not been kept together since birth. Nevertheless, with careful husbandry and special attention to environmental enrichment, such problems can be avoided or overcome. An increasing number of establishments have reported success in housing rabbits in groups since the Working Party first met.

The Working Party also agreed that group housing will not be suitable for all animals and at all times. In situations where animals have to be caged, the advantages and disadvantages of different types of caging (for example, wire, plastic and metal cages) should be carefully evaluated. Consideration should be given to housing animals in compatible pairs and, most importantly, the environment should be maximally enriched. There are many ways of doing this which produce noticeable improvements to the animals' well-being.

Group housing systems can be more economical to set up and run, and are more rewarding for animal handlers and technicians. They create a more humane climate that encourages people to see animals as individual living creatures rather than just a tool for research.

The Working Party felt that further information was needed on a number of points in order to establish and be able to provide the best environment for rabbits. Specific areas of research were identified and are listed in Appendix 2.

APPENDIX 1

Natural behaviour patterns carried out by rabbits

Air-boxing Fast forward flicking of forelimbs whilst rabbit sits upright on haunches. Usually precedes body grooming.

Biting Seen during inter-or intra-sexual chasing/ fighting.

Body-rolling Rabbit throws itself onto ground in a sideways roll, may lie immobile in outstretched position on side with eyes half closed for some seconds after roll. Often performed as dust-bathing in the wild.

Bowing Head lowered, neck outstretched (sometimes with eyes partly or fully closed) towards approaching rabbit.

Chasing Rabbit rapidly pursues another, often with tail erect.

Chin-marking Rubbing the chin over an object or conspecific, releasing secretion from the chin gland.

Circling

Courtship circling - male runs semi-circles, in alternating around stationary or slow-moving female.

Aggressive circling - rapid chasing around and around in one spot; participants may have rear end of opponent gripped between their teeth.

Coprophagy/Re-ingestion Rabbit removes, chews and swallows soft, mucous-covered coprophagy pellets directly from anus.

Copulation Sexual mounting and thrusting followed by ejaculation. Successful ejaculation accompanied by male vocalization as he falls backwards/sideways off the female.

Defecation Release of faecal pellets.

Digging Prolonged paw-scraping at deep substrate, usually associated with burrow excavation.

The substrate is thrown under and behind the body, and the rabbit may turn and push the displaced spoil further back with alternate forward thrusting movements of the forepaws.

Displacing Rabbit approaches another, replacing it at its location.

Drinking Lapping up water with tongue (not normally seen in wild rabbits which appear to extract most of their water requirements from their plant food material).

Feeding Taking food material into mouth, chewing and swallowing.

Fighting Involves aggressive attack with limbs or teeth, often with combatants leaping into the air/past each other.

Foot thumping Loud thumping of the ground with the hind-foot (feet), usually when alarmed but males may also foot-thump after mating.

Fur-pulling Only performed by females. Rabbit pulls mouthfuls of hair from her body in order to line her nest prior to parturition.

Gnawing Gnawing wood or other solid material with teeth.

Grooming A full body groom is usually preceded by air-boxing (see above). The forelimbs are then licked and passed over the head and ears, prior to licking/nibbling of fur over the rest of the body.

Rabbits may also lick the fur of another rabbit (usually around the head, particularly the ears), typically of the opposite sex.

Locomotory

Hopping-forward movement achieved by alternate extension of fore and hindlimbs. Distinguished from running by its slower speed and shorter distance covered per forward jump. Jumping-vertical movement by rabbit either onto an elevated surface or into the air. The latter may occur, for example: (a) when surprised by another rabbit; (b) during jumpfighting between same or mixed-sex pairs of rabbits (see above); or (c) during play gambolling (see below).

Play gambolling-forward hopping/jumping accompanied by sideways tossing of the head/ears.

Young rabbits may also run back/forth at some speed during this activity.

Parallel running-two rabbits run in parallel, with elevated gait, tail erect and at a slow pace, along a mutual territorial boundary. May be interspersed with bouts of jump fighting (see below) and/or parallel paw-scraping and scent marking displays.

Running-rapid forward movement achieved by alternate, fully-stretched extension of fore and hindlimbs.

Mounting Sexual mounting of hindquarters (or head) of conspecific. May see homosexual mounting by males or females grouped in the absence of opposite sex individuals in captivity.

Olfactory investigation Close sniffing of object/conspecific.

Nest-building Female gathers mouthfuls of nesting material (usually dry, long grass, but may use other soft, loose material if no grass is available), carries them to an underground nesting site and builds a nest which she then lines with fur plucked from her own body.

If nesting in a purpose-built breeding-stop, the female emerges and then digs soil into the tunnel to close the entrance. The soil will then be patted down by alternate, downward thrusts of the forepaws and a small volume of urine and a few faecal pellets deposited on top. This same closing and patting-down action may be seen in domesticated rabbits at the entrance of their cage/pen nest box.

Nose to nose approach Two rabbits approach head on with necks outstretched to sniff nose to nose and/or nose to chin.

Nose to tail approach One rabbit approaches another from the rear and sniffs under its tail (typically in the context of a male sniffing to determine the oestrous status of a female).

Pawscrapping Rapid scratching at the ground with the forepaws in the context of: (a) foraging (typically for roots); (b) aggressive encounters between two rabbits; or (c) a scentmarking session by a rabbit alone. Scent products in the form of urine, faeces and/or chin-gland secretions are typically deposited during (b) and (c).

Rearing Sitting up on hind-limbs with both forepaws off the ground; ears partly or fully down.

Rearing alert As above but with ears erect.

Resting

Sitting - in upright stationary position, with rear end and forepaws on the ground and ears down.

Sitting alert - as above, but with ears erect.

Lying, limbs tucked under - resting with trunk on ground, hindlimbs tucked under the forelimbs lying under or forward stretched from body.

Lying, limbs outstretched - resting with body trunk on ground, all four limbs outstretched and belly exposed. Rabbits often sunbathe in this position.

Scratching Scratching at own body with a hindfoot.

Sexual following Male approaches female from behind and she moves forward with male repeatedly following. He may sniff under her tail and put his chin on her rump as a prelude to mounting, before she moves away. An unreceptive female will usually tail-flag (see below) as he moves away.

Sexual submission Female crouches with tail fully erect so that a male may mate with her.

Tail-flag Rabbit has tail fully vertically erect (typically during aggressive/courtship interaction).

Tail-wagging Outstretched tail is flicked rapidly from side to side by female (typically in the context of a rear approach by a male).

Urination

Squat urination - the hindquarters are lifted slightly and extended backwards and urine released in a continuous, downwards-directed flow.

Urine squirt - with hindlimbs typically extended and tail erect, the rabbit squirts a short jet of urine out behind.

Urine spray (or enurination) - a short jet of urine is emitted during a twist/jump action where either the whole body, or the hindlimbs alone, are lifted and the hindquarters swung around in a semi-circle. Typically, this spray is directed at another rabbit, either during courtship or an aggressive encounter.

APPENDIX 2

Research recommendations

To ensure that rabbits are provided with as natural environment as possible in any given situation, further information on a number of subjects is required. Some of these are listed below:

1. The behavioural repertoire and identification of behavioural needs/requirements/preferences. Comparison of group housed and caged rabbits.
2. The physiological and psychological responsiveness of animals group housed in pens compared with those caged singly or in groups.

3. Identification of strain differences in aggressive behaviour.
4. Whether castration reduces aggression in mature or immature animals before or after they have experienced fighting.
5. The effect of day length and the need for a crepuscular period.
6. The relationship between the proximity of the opposite sex and levels of aggression.
7. Variation in sound levels over 24 h in different housing conditions, e.g. pens versus cages; plastic versus metal cages; different stocking densities.
8. Effects of sound on both physiological and behavioural parameters.
9. The effect of mixing animals in relation to stress and injury.
10. Design of a cage such that it meets animals' behavioural as well as physiological needs, yet remains easy to clean and maintain.

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Additional information

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Videos

Handle With Care and *Procedures With Care* (IAT). Available at £24.00 and £32.00 (plus postage and packing) respectively. Further information from Mr T Wills, Murex, PBS Building, 71 Central Road, Dartford, Kent

Note

Reprints of this Report are available free of charge from RSPCA, Research Animals Department, Causeway, Horsham, West Sussex RH12 IHG, UK.