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STRUCTURAL ACTION TO REDUCE THE ENVIRONMENTAL IMPACT OF PIG FARMS IN A DISTRICT OF EMILIA IN NORTHERN ITALY

by

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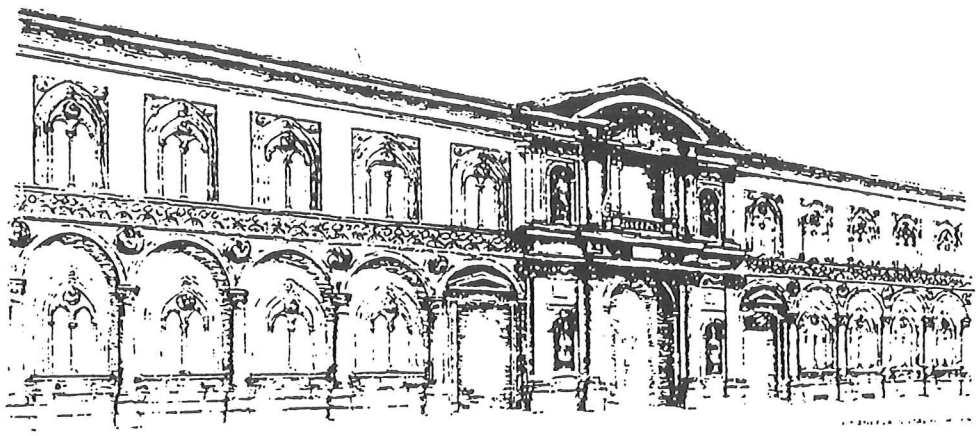
SUMMARY:

To evaluate the gravity of problems concerning land protection within the reality of a district of Emilia-Romagna, research was carried out involving 155 farms. In the course of the survey, 1862 rooms were noted and classified. Although the district of Modena is situated in a major pig-farming area, unfortunately there were found to be many obsolete buildings, with irrational means of manure removal (60%). 21% of farms have crumbling buildings that require radical renovation. Possible improvements have been identified to: a) limit the overall production of slurry; b) allow the production of solid portions (muck).

KEYWORDS: pig houses, land protection, slurry



1. Introduction

In areas of high density livestock breeding, problems concerning land protection, health, and environmental hygiene on farms are prominent. The seriousness of these problems is related not only to territorial aspects but also to the building construction solutions adopted on the individual farms.
Farm management of slurry presents a series of limitations that hamper its correct agronomic utilization. In particular, emphasis should be given to the high production of slurry per head of stock. This is mainly due to cleaning systems that use a great deal of water for washing, in addition to a lack of attention to wastage of water from drinkers and to feeding techniques, along with insufficient separation of rainwater from slurry.
The negative consequences ascribed to pig farms could often be greatly reduced, or even eliminated, by appropriate organisation-planning choices.

2. Methods

To evaluate the gravity of these problems within the reality of a district of Emilia-Romagna, comprising 11 Municipalities of the Province of Modena, research was carried out involving 155 farms.
The facilities present on the farms examined were classified as follows:
Environmental unit : a single space delimited by walls, for breeding use (room).
Building : a space constructed under a single roof in a unitary and homogeneous manner.
Building complex : a group of buildings physically connected.
The research was split up into different phases:
a) acquiring basic data relative to the farms within the local authorities concerned;
b) defining types of buildings and finalising the questionaires to collect data in the single buildings;
c) surveying the farms to verify the building structures;
d) data processing with the aid of computers, especially by preparing software that could then be used by the single local authorities.

2.1 Acquisition of the basic data on farms from the local administrations

A consultation of documents related to applications for manure spreading authorization, carried out during the period August-October 1991, unfortunately provided widely unsatisfactory results.
Documentation related to the farm structure was considerably lacking, particularly as regards detailed plans of the building layouts, which are necessary for calculating the useful surface area, i.e. the parameter used to determine the maximum pig-raising potential. Reliable up-to-date building plans were not available for approximately 60% of the farms. Data on the storage facilities was also lacking in many cases, in particular as regards the calculation of the capacity of these facilities.

2.2 Definition of the building types and completion of the data acquisition cards

The second phase of study involved the definition of the building types for the various breeding phases in terms of structural characteristics, stalling methods and waste removal techniques.

The specific survey cards were then defined. The classification was organized according to the various breeding phases into categories defined on the basis of numerous parameters, with particular attention given to those parameters related to the type of flooring of pens and cages, and the slurry collection and removal systems.
The constructive and dimensional characteristics comprised an important classification criteria, in view of any improvement or renovation projects at the level of buildings or systems.
Data was also collected on the watering systems and environmental control techniques.
The questionnaires were adjusted after on-site surveys of a number of farms.

2.3 On-site surveys
Certainly the most delicate phase of the study was that in which data was collected directly on the farms, due to the difficulty of access to farm buildings, particularly prominent in periods characterized by serious health problems (epidemics of foot-and-mouth disease).
The on-site survey was carried out in three phases:
- the presentation of the study to the breeder, with the aim of creating a reassuring atmosphere of collaboration between the researcher and the breeder. Breeders refused to furnish information on their farms in only two cases.
- compilation in the office of the farm survey card, including general information, particularly as concerns refuse management.
- on-site visits to the individual buildings, with completion of the specific survey cards.

2.4 Computer processing of the data
Another extremely important phase was that in which the data collected was transferred from paper to computer. The data processing programme used was completed in February-March 1993.
The archives comprise the 155 farms identified, specifying the various units that are part of buildings or of building complexes where present. From the main menu, access can be made to the individual farms, and from there to the single units, which can be called in order of building, complex, or production phase.
The information collected in the farm questionnaires is provided in the cards for each environmental unit.
The data contained in the archives can be processed in various ways, for example: a) selecting a municipality or processing the information for the entire territory; b) choosing a single production phase; c) requesting processing for a single variable; d) cross study of two variables; e) cross study of three variables, obviously keeping one fixed.
The processing can be done by unit or by farm.
In addition, a summary of the data for the various units that make up the farm is shown in a preliminary table that illustrates the overall situation, dividing the production cycle into the various categories of animals. For each of these categories, data is provided on the number of head, and thus the potential and the related production of slurry, calculated in terms of the housing systems of the animals and dung removal based on the parameters established by the Emilia-Romagna Region. The overall slurry production value is then compared with data on the capacity of the storage basins for the minimum period established by the regional regulations (180 days).
At present, the archives contained in the programme provide a picture of the situation

found in the farms of the territory during the on-site visits. The data processed in these archives makes it possible for us to formulate considerations on the existing building situation and thus to propose modifications for improvement in order to reduce the risks of pollution.

A fundamental aspect of this study, especially as regards the local administrations, is the dynamic nature of these archives. The data collected during the winter of 1991-92 should be updated by the individual municipalities, obviously as regards the farms under their jurisdiction, in order to keep the farm situation under control. The programme makes it possible to update the information for each individual unit and also to add or delete units.

In addition to updating the information on the number of head of animals present in the individual units, the local authorities should note any changes in buildings or systems that would involve variations in the cleaning techniques (and thus affect slurry production). The quick updating operation for the information on the various environmental units permits real-time data on slurry production as well as on the number of swine in the entire municipality.

3. Results

During the course of this survey, 1862 environmental units were identified and classified.

For obvious reasons of space, the large quantity of information collected during the study cannot be discussed in its entirety in this report.

Table 1 Cleaning systems divided into the various production stages (fat=fattening; gro=growing; mix=stock replacement, infirmary, mixed stages etc.; wea=weaning; far=farrowing; ges=gestation-insemination)

DRY CLEANING SYSTEMS	FAT	GRO	MIX	WEA	FAR	GES	TOTAL	%
Continuous gravity flow system - channel with fixed weir	13	23		14	13	9	72	4,01
Continuous gravity flow system - channel with moving weir	19	30	9	24	7	15	104	5,80
Discontinuous gravity flow system - channel with sluice-gate or plug	10	11	3	48	18	17	107	5,96
Discontinuous gravity flow system - channel with piping and valve					7	1	8	0,45
Deep strorage channel	71	1	4			2	78	4,35
Flushed channel - slurry recirculation by means of pumps	5		6				11	0,61
Channel with scraper or mechanical conveyor	7	2	1		2		12	0,67
Channel with sloped flooring	74	57	11	26	62	55	285	15,89
TOTAL	199	124	34	112	109	99	677	37,74
CLEANING SYSTEMS WITH LOW WATER CONSUMPTION								
Solid sloped flooring, drainage gutter, washing with slurry					16	8	24	1,34
Solid sloped flooring, washing with slurry	5	3	2	1		1	12	0,67
Solid sloped flooring, washing with high pressure hot water cleaner	1	1	1	4	4		11	0,61
Solid dunging passage with self tipping tanks and recirculated slurry	9	4				4	17	0,95
TOTAL	15	8	3	5	4	5	64	3,57
CLEANING SYSTEMS WITH VARIABLE WATER CONSUMPTION								
Solid flooring, manual dry cleaning	41	12	34	8	7	22	124	6,91
Solid sloped flooring, drainage gutter, water cleaning				147	203	34	384	21,40
Solid sloped flooring with self-tipping tanks			1			2	3	0,17
Solid dung passage with self -tipping	10	21	1			13	45	2,51
Solid dung passage with sloped flooring	2						2	0,11
Underslat channel with self-tipping tanks	2	8		10	8	2	30	1,67
Solid sloped flooring, cleaning by animal trampling	4						4	0,22
TOTAL	59	41	36	165	218	73	592	33,00
CLEANING SYSTEMS WITH HIGH WATER CONSUMPTION								
Solid sloped flooring, water cleaning	113	67	40	75	94	72	461	25,70
TOTAL	113	67	40	75	94	72	461	25,70
OVERALL TOTAL	386	240	113	357	441	257	1794	100,00

We will thus limit ourselves to illustrating the most significant or interesting aspects that emerged from the processing of the data.
An examination of the data collected revealed that many of the farm facilities of the zone are somewhat obsolete.
Table 1 shows the cleaning systems found in the farms studied, subdivided into 4 categories: dry cleaning systems, which are considered acceptable and thus for which no modifications are recommended; cleaning systems with low water consumption; cleaning systems with variable water consumption, in relation to the management methods and/or constructive aspects; and cleaning systems with high water consumption. Cleaning systems that involve the use of water are generally considered inadequate due to both the excessive cost of the operation and the great use of water with consequent dilution of the slurry and related problems of storage and spreading.
The table shows that 62.27% of the units use irrational cleaning systems, and more than one-fourth of the units (25.7%) showed a particularly high level of water consumption.
For each type identified, a detailed analysis was made in order to reveal the main constructive features (type of flooring, type of roof, etc.) and organizational characteristics (frequency of cleaning, actuation of "all-in all-out", etc.).
As one of the aims of this study was to indicate the lines of renovation for existing buildings, we also considered the conditions that could hamper the carrying out of any improvement projects. Thus, restrictions inside the buildings were identified (pillars, chains or trusses, masonry works, vicinity to other buildings, layout on one or two floors), as well as exterior restrictions, i.e. those determined by the position relative to other buildings or infrastructures (roads, canals, etc.).
Of the units considered irrational in terms of dung removal, 40.1% present one situation of restriction to the restructuring project, and 36.7% present two or more restrictive conditions. Only in 23.2% of the cases, the units were completely free of restrictions. Thus, the choice for the most appropriate type of modification for a space must be based on a thorough study of the building.
A general picture of the situation found in the farms involved in this study is given by Fig.1 .

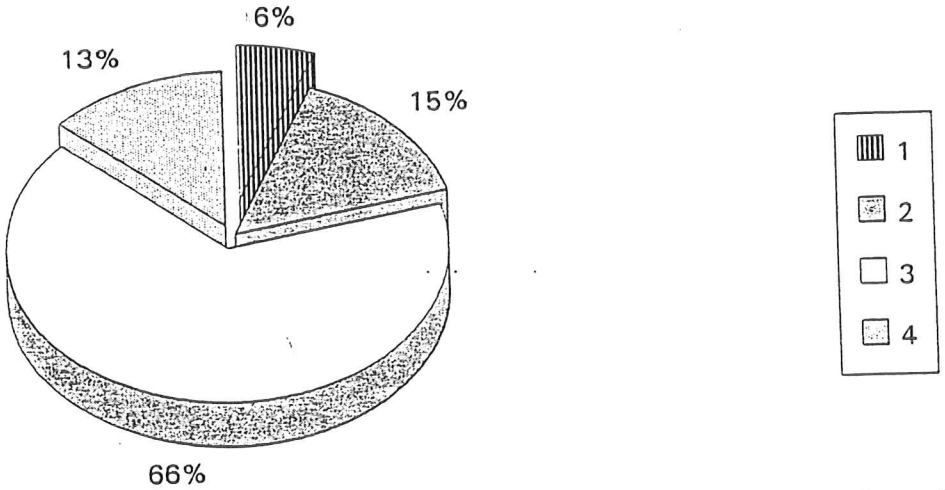


Fig.1 Pig farms situation. 1)Farms in precarious conditions; 2)farms that require radical transformation; 3)farms that need some modifications; 4)farms in optimum condition

The farms are divided into 4 categories. Those defined as being in precarious conditions

are farms with obsolete structures in very poor condition, with serious lacks also in terms of farm organization. This situation leads to problems related not only to slurry management but also to the health and well-being of the animals being raised. This category involves 6% of the total farms examined. Another 15% comprise farms in need of radical transformation. These farms often have a very old central structure which would be difficult to recover without an intervention involving the demolition of existing buildings and construction of new ones. In the next category, 66% of farms were judged to be in need of only a few modifications. Finally, 13% of the total farms could be considered to be currently in optimum condition.

The situation of the farms judged to be in precarious conditions, or in any case those needing massive modification, merit further consideration. The farms in these two categories are generally small, with an average of approximately 7 units compared to the average of 16 units per farm in the other categories. These are often farms that exclusively produce piglets, and have a limited number of sows (an average of fewer than 100).

The judgement that results from the study carried out is that of family-run farms (often by only one person) that have not adjusted to the times over the last few years, presumably for reasons tied to the absence of other family members interested in carrying on the activity. These farms thus have extremely limited possibilities for development.

On the other hand, the larger farms often show a favourable situation as regards the cleaning systems used. The large farms, in fact, were the first to see the need to adopt rational cleaning systems, both to improve the general handling of slurry and to reduce the use of manual labour.

Finally, a definition of the possible improvements was made for the various types identified. For this purpose, solutions for transformation of existing buildings involving low environmental impact are proposed (Fig.3). These solutions involve dry cleaning systems with specific dung zones (exterior channels or interior dung zones), with entirely slatted floors. As an alternative, solutions are proposed that lead to the production of muck rather than slurry through the use of straw or other bedding material.

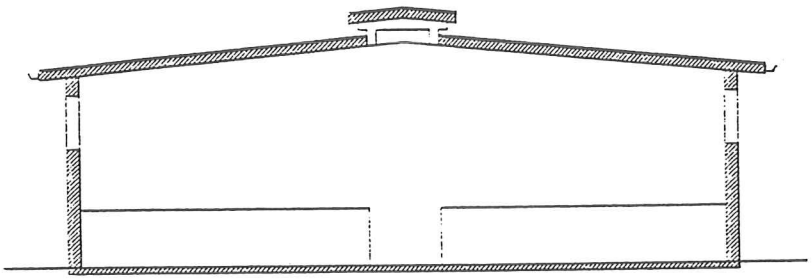


Fig.2 Pig houses with solid floor pens

As an example, given the large number of types found, it could be interesting to illustrate a particularly negative situation, i.e. that constituted of building types with solid floor pens, without well-defined dung zones (Fig.2). In these situations, in fact, water must of necessity be used for cleaning, often in large quantities, or irrational manual cleaning systems are used. Table 2 shows that 13.8% of the units are in this situation, though with different types, with one or two rows of pens, with or without

interior passageway.

Table 2 Number of pig houses with solid floor without dunging area

Production stages	Solid flooring without dunging area	
	one row	two rows
	n°	n°
Fattening	62	43
Growing	15	30
Replacement stock	5	5
Mixed stages	10	5
Quarantine-infirmary	8	10
Gestation	14	28
Insemination	4	4
Total	**118 (6,70%)**	**125 (7,10%)**

In the case of pens with solid flooring, various improvement solutions could be adopted, for example:
- creation of exterior dung channels (solutions B, C, D, E)
- creation of interior zones with slatted flooring (solutions F, G, H, I,)
- creation of entirely slatted pens (solutions L, M, N, O)
- solutions with straw bedding or deep sawdust bedding (solutions R, S,T)

The choice of the solution to adopt is influenced by a number of factors, both constructive (height of the building, presence of pillars or trusses, space available around the pigsty, etc.) and zootechnical (choice of the stalling system in relation to the age of the animal and the production aim), as well as ecological-agronomic factors (choice between slurry and muck, with all the related considerations).

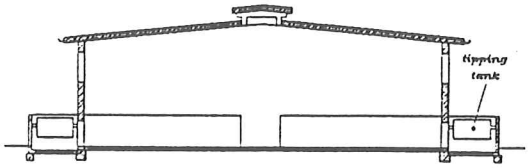
4. Conclusions

The study made on 155 farms of the territory of Modena had two fundamental aims:
- first of all, to permit an extremely in-depth and detailed examination of the existing farm building situation in the territory;
- and then, to provide the municipal administrations with a useful instrument for studying the current conditions and for updating information on the pig-breeding situation.

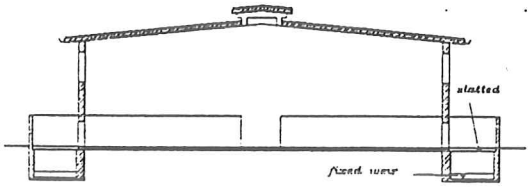
Though the territory of Modena is located in one of the most important swine-producing areas, the study revealed numerous obsolete buildings with irrational dung removal procedures which can lead to a higher consumption of water and consequently the production of highly diluted slurry. It would be advisible to intervene in this situation, also by drafting legislation that would encourage the rational restructuring of the farms on the basis of the indications proposed and reported in this study as examples for certain solutions.

Otherwise, the risk is that we will see the slow but inexorable decline of pig-raising activity, which would have negative repercussions on a variety of other production activities that are deeply rooted in the Emilia territory.

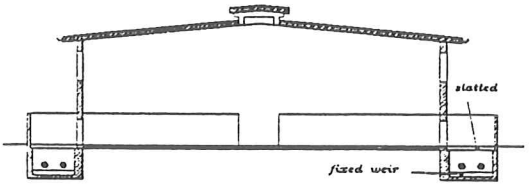
A) Solid floor exterior dunging area with self-tipping tank



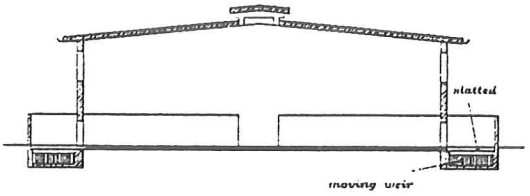
B) Slatted exterior dunging area – continuous gravity flow system with fixed weir



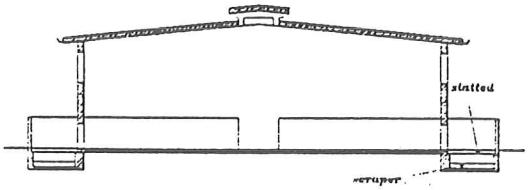
C) Slatted exterior dunging area – channel with slurry recirculation



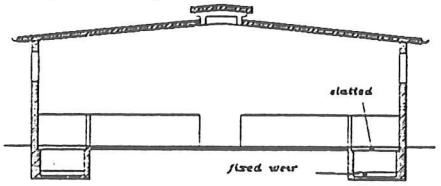
D) Slatted exterior dunging area – continuous gravity flow system with moving weir



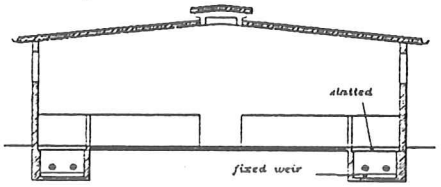
E) Slatted exterior dunging area – channel with mechanical scraper



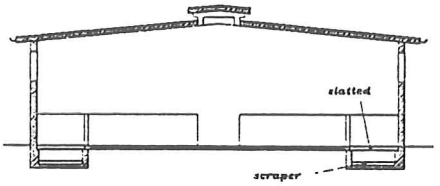
F) Slatted interior dunging area – continuous gravity flow system with fixed weir



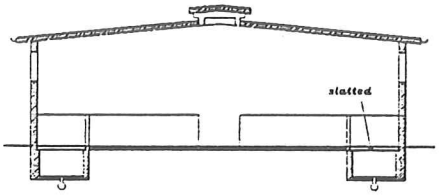
G) Slatted interior dunging area – channel with slurry recirculation



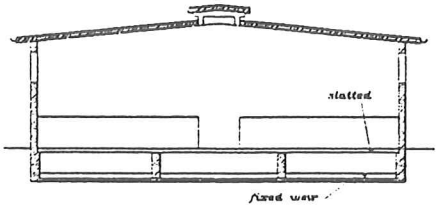
H) Slatted interior dunging area – channel with mechanical scraper



I) Slatted interior dunging area – discontinuous gravity flow system



L) Total slatted floor – continuous gravity flow system



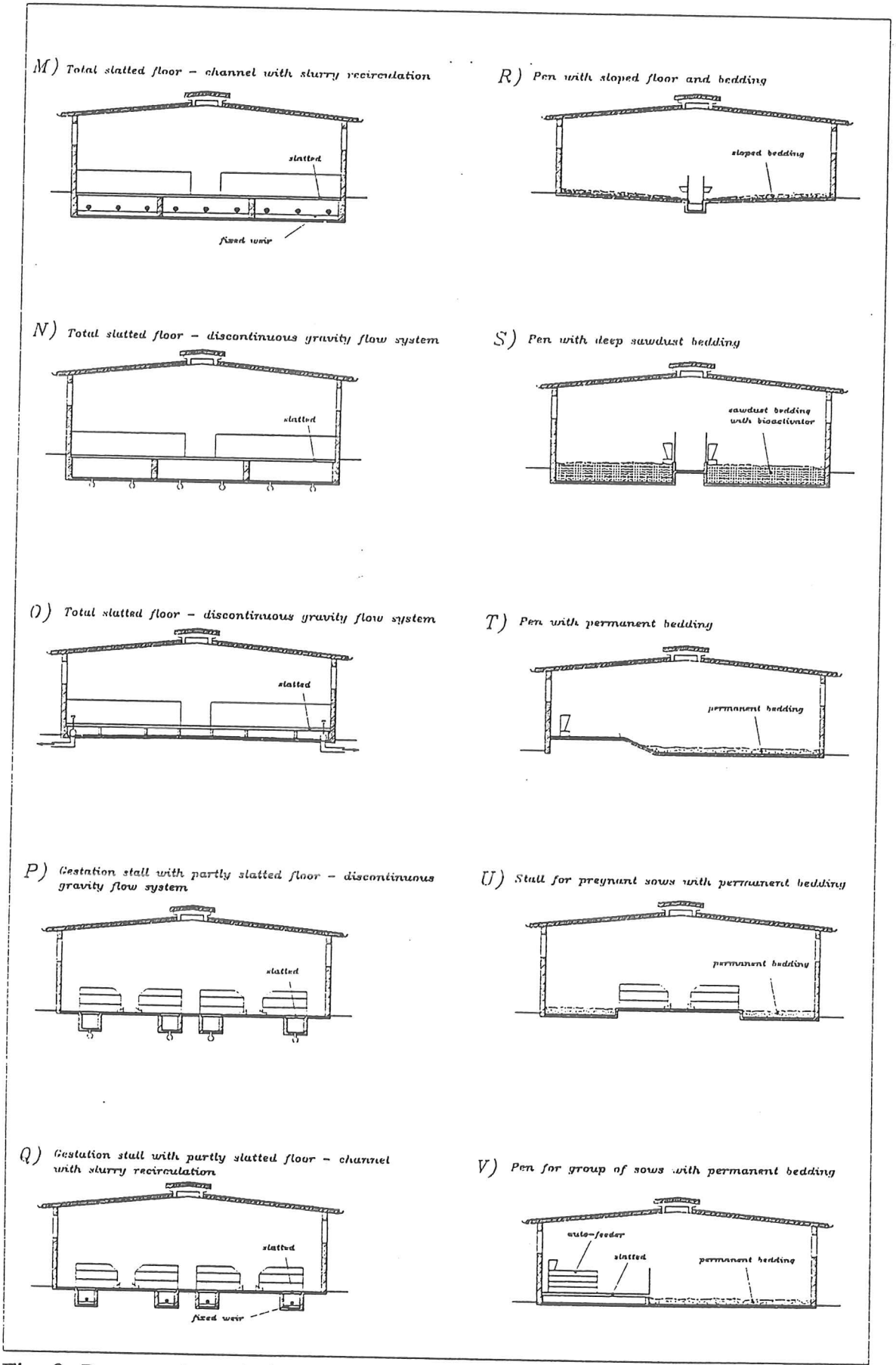


Fig. 3 Restructuring solutions for pig houses involving low environmental impact