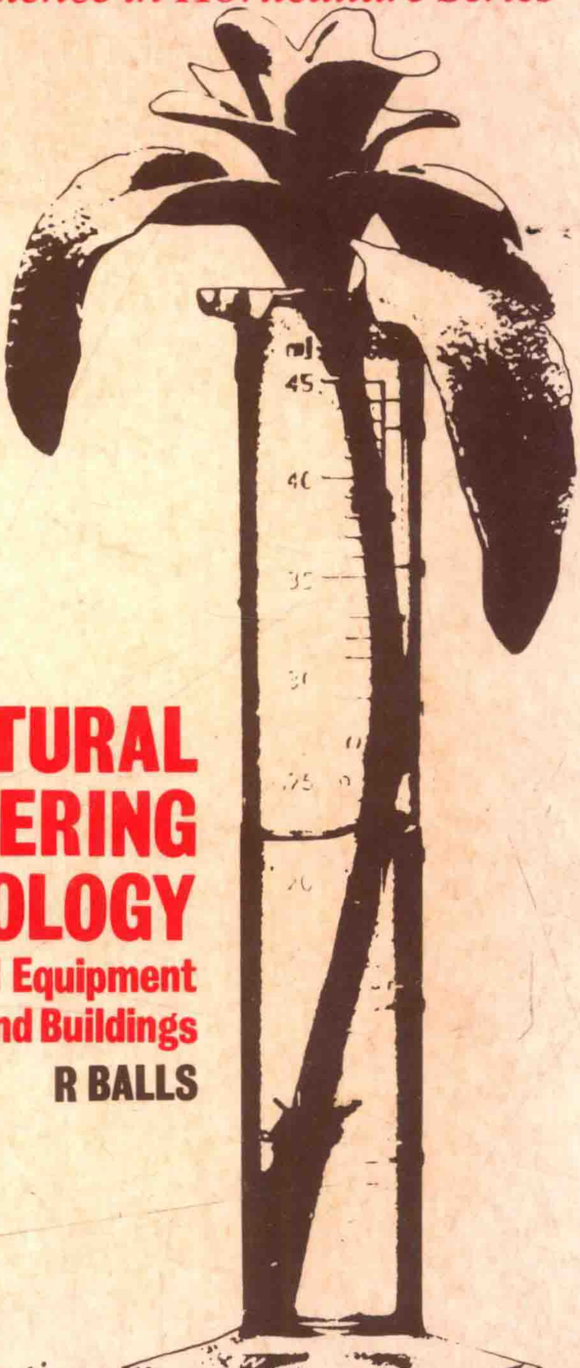
Science in Horticulture Series



HORTICULTURAL ENGINEERING TECHNOLOGY

Fixed Equipment and Buildings

R BALLS

Published in collaboration with the Horticultural Education Association and the Royal Horticultural Society

HORTICULTURAL ENGINEERING TECHNOLOGY

FIXED EQUIPMENT AND BUILDINGS

R.C. BALLS
ANCAE

National Specialist Mechanisation Adviser with the Agricultural Development and Advisory Service (ADAS) of the Ministry of Agriculture, Fisheries and Food, U.K.

MACMILLAN

First published 1986

Published by
MACMILLAN EDUCATION LTD
Houndmills, Basingstoke, Hampshire RG21 2XS
and London
Companies and representatives
throughout the world

Printed in Hong Kong

Typeset by
TecSet Ltd, Sutton, Surrey

British Library Cataloguing in Publication Data
Balls, R. C.
Horticultural engineering technology: fixed equipment and buildings.
1. Horticultural machinery
I. Title
635'.028 5678.7

ISBN 0-333-36435-X

HORTICULTURAL ENGINEERING TECHNOLOGY
FIXED EQUIPMENT AND BUILDINGS

Science in Horticulture Series

General Editor: L. Broadbent, Emeritus Professor of Biology and Horticulture, University of Bath

Published in collaboration with the Royal Horticultural Society and the Horticultural Education Association.

This series of texts has been designed for students on courses in horticulture at the Higher Diploma or National Diploma level, but care has been taken to ensure that they are not too specialised for lower-level courses, nor too superficial for university work.

All the contributors to the series have had experience in the horticultural industry and/or education. Consequently, the books have a strong practical flavour which should reinforce their value as textbooks and also make them of interest to a wide audience, including growers and farmers, extension officers, research workers, workers in the agrochemical, marketing and allied industries, and the many gardeners who are interested in the science behind their hobby.

The authors are all British, but they have illustrated their books with examples drawn from many countries. As a result the texts should be of value to English-speaking students of horticulture throughout the world.

Other titles in the series are:

J. K. A. Bleasdale, *Plant Physiology in Relation to Horticulture (Second Edition)*
G. R. Dixon, *Plant Pathogens and their Control in Horticulture*
A. W. Flegmann and R. A. T. George, *Soils and Other Growth Media*
S. D. Holdsworth, *The Preservation of Fruit and Vegetable Food Products*
C. North, *Plant Breeding and Genetics in Horticulture*
M. J. Sargent, *Economics in Horticulture*
R. J. Stephens, *Theory and Practice of Weed Control*
E. J. Winter, *Water, Soil and the Plant*

and the companion volume to the present book

R. C. Balls, *Horticultural Engineering Technology – Field Machinery*

PREFACE

I have often felt that 'horticultural engineering' lies uneasily between the horticultural sciences and pure engineering. The horticulturist or plant scientist often finds engineering principles difficult to grasp, while the pure engineer usually lacks the practical knowledge of plant behaviour or requirements.

The modern horticulturist is heavily reliant on engineering by way of mechanisation at all stages from establishment to marketing. A working knowledge of engineering will help in three ways: awareness of what is available, ability to specify requirements in broad terms and improved efficiency of operating equipment.

In writing this book I have tried to establish the basic engineering principles of which the modern horticulturist must be aware, and to describe the equipment that is likely to be encountered. It is also hoped that students or practitioners of engineering will be able to grasp the basic applications requirements of the horticultural industry.

Obviously, as the book has to cover such a wide range of engineering sciences, some cannot be explored in great depth, and consequently the reader will have to continue by way of the books cited in the bibliography. Attention is also drawn to the companion volume: *Horticultural Engineering Technology – Field Machinery.* In line with the majority of the engineering industry, the two books are written entirely in SI (Système International) metric units; conversions to Imperial and other common units will be found in appendix A.

Houghton Conquest
Bedford

R. C. BALLS

ACKNOWLEDGEMENTS

I would like to acknowledge the help given by colleagues in the Advisory Services and Research Stations, and also the information supplied by equipment manufacturers. The following companies and organisations have kindly allowed their drawings to be copied: CIBSE, London (figure 7.19); The Electricity Council, London (figures 6.5 and 6.6); Hamworthy Engineering Ltd, Poole (figure 4.3(b)); Spirax-Sarco Ltd, Cheltenham (figure 5.3(a)-(d)); and Woods of Colchester Ltd (figures 7.14, 7.15 and 7.17).

Full use has been made of my experience gained during advisory work on horticultural holdings throughout Britain, and I am grateful for the permission to draw on this work given by my senior officers in ADAS. Finally I am indebted to my wife for typing the manuscript.

CONTENTS

1 PACKHOUSE DESIGN AND OPERATION

The design of packhouse equipment, and its layout, is often specific not only to the product, but also for the intended market. However, many operations in the various processes are widespread, and can be discussed under the following general groups of activity: reception; intake; cleaning; quality grading; size grading; preparation for market; weighing and packing.

1.1 RECEPTION

The produce will often arrive in containers which can be as diverse as 600 mm x 450 mm x 300 mm crates for celery, water-filled buckets for flowers, and 22 tonne bulk lorries for potatoes or onions.

These products will often need space for storage, as the packhouse usually cannot deal with a delivery immediately it arrives. There will be a minimum requirement for space to stand trailers, pallets and bins. This must be away from the areas of other activity, and often must allow for temporary storage of varying discrete lots, with access to each as might be required.

1.1.1 Weighing

In large packhouse operations the incoming produce will need to be weighed. This is normally done on a weighbridge of sufficient size to take the entire vehicle; modern lorries require a bridge deck at least 12 m x 2.7 m, with a weight capacity of 40 tonnes. The modern weighbridge uses an electronic rather than a mechanical system. This has several advantages, such as reduction in site work requirements, automatic taring and computer interfacing.

(a) Automatic taring enables a vehicle to be weighed when full, then empty, and the load weight automatically calculated, with all details being printed on a ticket. Some units have a 'memory' function, which holds details of several vehicles, and can recall the appropriate full weight when a vehicle returns after discharging its load.

(b) Computer interfacing enables all the weight data to be incorporated into the stock control system.

(c) Modern electronic weighbridges do not require to be sited over a deep pit to house all the levers; many electronic loadcells project less than 50 mm below the deck, so the whole weighbridge can be sited above ground level, with low access ramps each end.

Weighbridge siting must allow for access to vehicles entering and leaving the site, without generating blockages caused by vehicles waiting in the reception or dispatch area. Often when they are carrying produce from more than one grower, it is necessary to allow for incoming produce vehicles to return for reweighing, so that each lot can be weighed off separately.

1.1.2 Weather protection

Many products need to be protected from rain or the extremes of sun and cold. Where produce is left on trailers, tarpaulin sheeting can provide rain protection but will not be proof against frost unless both trailer body and sheet are thermally insulated. Tightly drawn sheeting can lead to high humidity and condensation spoilage in the crops beneath.

1.1.3 Conditioning during holding

Some produce, like onions, benefits from ventilation while in the holding area, to dry wounds caused during loading. Bulk trailers can be fitted with a fan and ducting; bulk bins can be stacked on to a force ventilation duct system.

1.1.4 Cold chain reception

Some produce quality requirements dictate that the produce is cooled as soon as possible after harvesting. In many instances the best opportunity for cooling is in a specialist cold store (see section 7.3) sited at reception. The cooling in most units will take a matter of hours, and it is normal to load the cooler one afternoon for packing the next morning. The cooler siting must allow access for both filling and emptying without conflict with other movements in the intake area.

1.1.5 Emptied container storage

Many bins occupy the same space when empty as they do when full. There must be provision for movement and storage of these while awaiting collection, and access to discrete lots for reloading on to transport.

1.2 INTAKE

The bulk of produce that arrives has to be broken down into a steady, even feed for the succeeding operations. The produce will often travel through the packhouse by conveyor, so the main intake operation will involve feeding this by one of the following methods.

1.2.1 Hand feed

Produce is transferred manually from the crate, bucket or bin to the intake conveyor. In operations where the first task involves mechanical processing, for example leek and celery trimming, the produce has to be laid out in correct alignment. The ease with which material can be handled depends on the state in which it arrives. A jumbled mass of celery sticks in a bin requires much sorting. If these have been placed systematically in a crate during lifting, they can be tipped on to the intake already aligned, and so need little further correction. The intake operators will often carry out primary grading, rejecting obvious rubbish or pre-sizing where a twin size intake is involved.

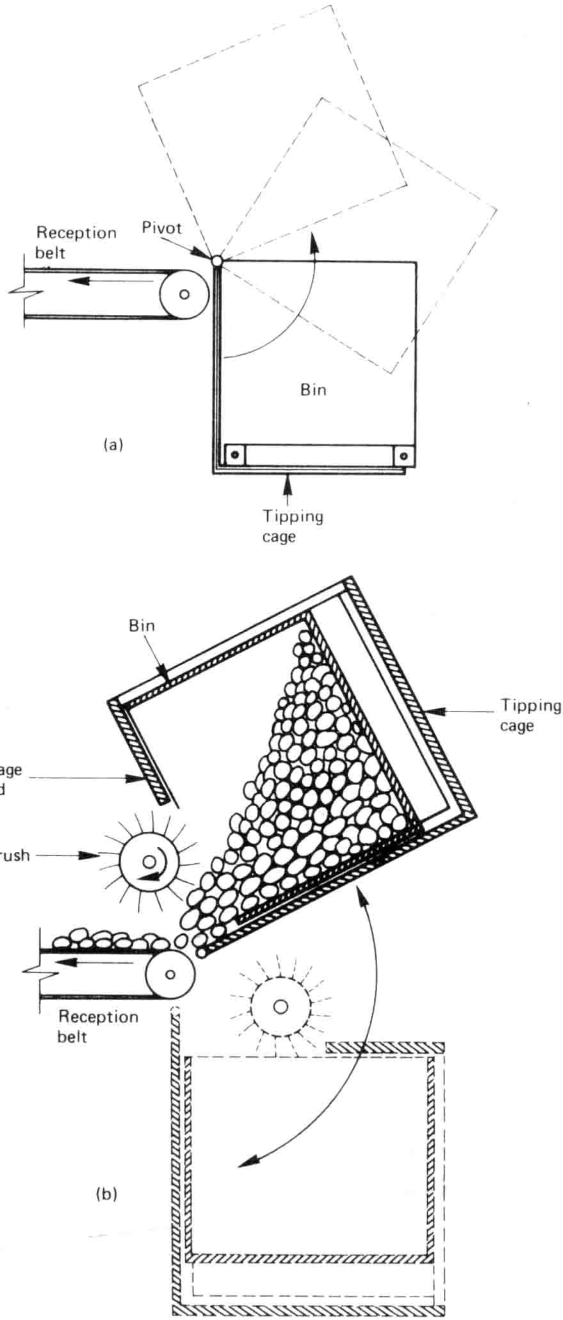
The material flow path must ensure that full and empty containers move freely within the intake. Roller conveyors can be used for small containers, with a separate one for full and empty ones. Large operations often employ one operator to take full crates from the pallet or trailer and restack the empty ones. Bins can be moved in by forklift or pallet truck, and manually pushed aside when empty.

1.2.2 Bulk bin emptying

Two methods are used to empty bins on to the line.

(a) The bin contents are tipped into a feeder hopper, which is a smaller version of that described in section 1.2.3, by either a forklift-mounted tippler, or a static tipping cage. Some static cages do not need separate power for tipping, the forklift tines being used to lift the rear edge.

To minimise damage when tipping any crop, the cage should tip the bin around its front edge (figure 1.1 (a)).


Reception
belt
Pivot
Bin
(a)
Tipping
cage
Bin
Tipping
cage
Cage
lid
Brush
Reception
belt
(b)