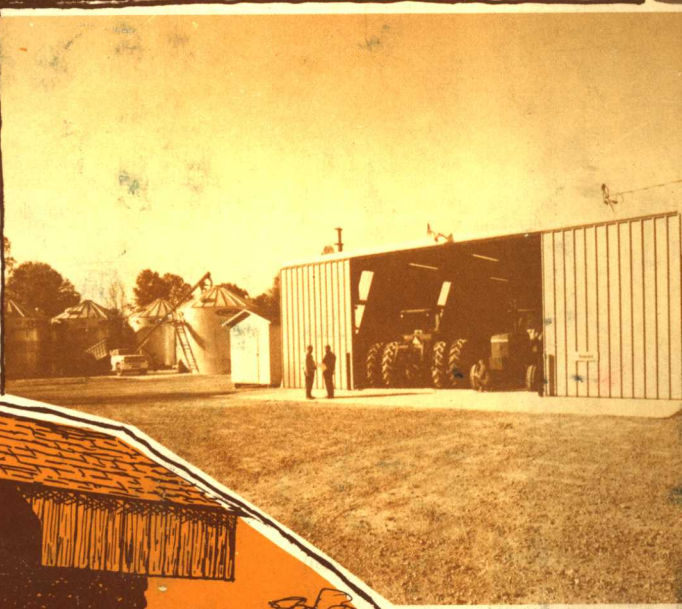
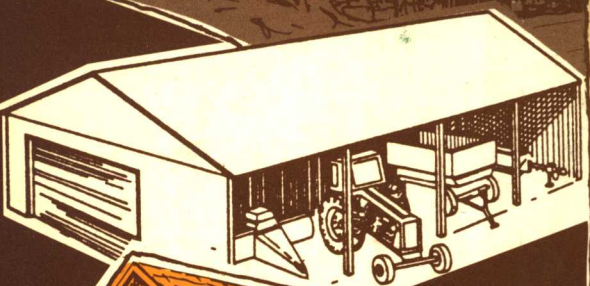
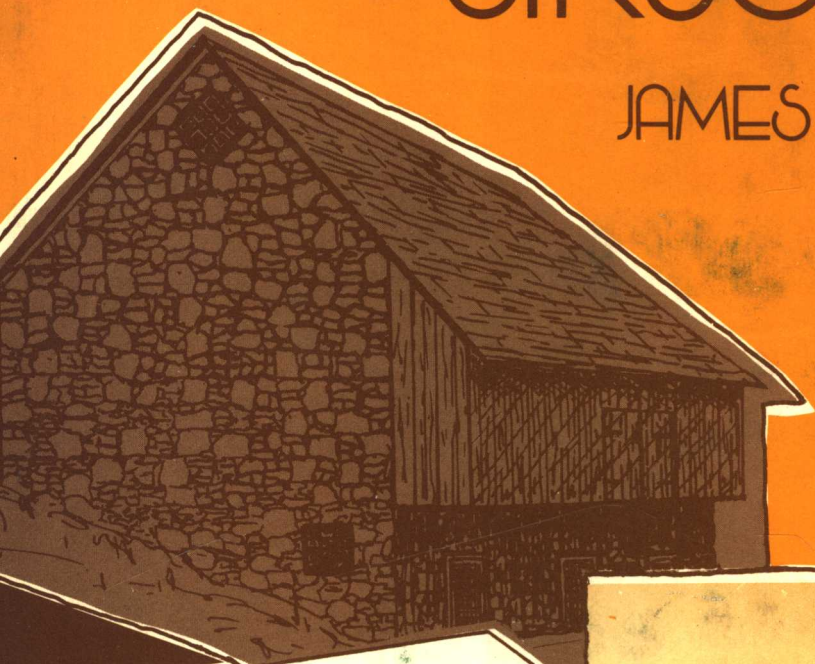


# AGRICULTURAL BUILDINGS & STRUCTURES

JAMES H. WHITAKER



# **Agricultural Buildings and Structures**

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# Preface

This text is designed to furnish the fundamental subject matter for a general course in farm structures for junior and senior students in agricultural mechanization or related agricultural curriculums.

It is intended to give a logical approach to the planning and design of structures in keeping with modern agriculture. While many design procedures are examined and illustrated, it is recognized that in some courses *method* rather than *theory* may be emphasized. For this reason, table material and standard practice designs are included in many cases. Although not intended as a handbook, a considerable amount of data required for design parameters are included. The book should be of value as a reference to vocational agriculture teachers, extension workers, and others interested in agricultural building design.

In recognition of the use of the SI metric system in Canada and in anticipation of conversion to this system in the United States, customary and SI Units are presented side by side throughout the book.

The book is organized in two parts. The first part begins with a brief review of the development of farm buildings in North America. After chapters devoted to the economic feasibility of buildings and farmstead planning, much of the balance of Part I deals with materials of construction and basic structural design. In addition, chapters covering heat transfer and solar energy, air-moisture relationships, and ventilation are included. And finally the subject of construction cost estimating is examined.

Part II is introduced with a discussion of a "systems approach" to planning and its importance in selecting, laying out, and designing buildings for specific farm enterprises. Housing requirements for dairy, poultry, and general livestock are included along with those for the storage of crops, and finally, greenhouses and several miscellaneous buildings are dealt with.

I am indebted to many people who have aided the progress of this book in its various stages. Appreciation and a sense of deep obligation are expressed to the authors of the numerous and varied resources used in the preparation of this volume. I extend my sincerest thanks to my colleagues at the University of Connecticut who have read parts of the manuscript and offered helpful suggestions and encouragement. I wish in particular to acknowledge the help of John W. Bartok, Jr., George A. Ecker, James A. Lindley, Ralph P. Prince, and William C. Wheeler as well as Robert G. Light of the University of Massachusetts.

My appreciation is also extended to the following persons from across the United States and Canada who supplied regional information: Gerald R. Bodman, University of Nebraska; Kenneth G. Boyd, Lambton County, Ontario; Theodore J. Brevik, University of Wisconsin; Frank D. Ciambriello, Orange, Connecticut; Keith A. Clark, Vineland Station, Ontario; George A. Duncan, University of Kentucky; W.C. Fairbank, University of California; George F. Grandle, University of Tennessee; Marvin E. Heft, Allegan County, Michigan Extension Service; Dexter W. Johnson, North Dakota State University; Franklin Kains, Regional Municipality of Waterloo, Ontario; Michael A. McNamee, University of Wyoming; Richard Phillips, University of Missouri; John Ed Ryan, National Forest Products Association; Frank H. Theakston, University of Guelph; and James F. Thompson, University of California.

And finally, I am deeply grateful to my daughter, Carol, for the illustrations in the first chapter and to my wife, Alice, for her loyal assistance and encouragement during this endeavor.

James H. Whitaker  
University of Connecticut

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# **Part One**

## **Planning, Materials, and Basic Design**

Part I presents basic principles relating to economic feasibility, farmstead planning and construction cost estimating. The characteristics and applications of building materials commonly used in agricultural construction are examined. Heat transfer and the control of building environment through ventilation are discussed. Inevitably, new building materials with superior characteristics will be introduced and continued research will develop refinements in the methods used to control environment. Nevertheless, the fundamental principles discussed will remain useful in developing plans, selecting materials, and designing safe, efficient, and effective buildings for modern agricultural needs.



# Chapter One

## Introduction

Buildings are an integral part of modern agriculture and contribute greatly to the efficiency of operation, the quality of the products produced, and the health and comfort of the workers and livestock. While the buildings of today are no more functional than the barns of past generations, they tend to be much more specialized. Often a *system* is chosen for an agricultural enterprise and then a building is selected or designed to provide the necessary conditions for the system. These conditions may range from little more than protection from wind and rain to sophisticated control of the building's total environment.

Eric Sloane (1966) accurately states, "The successful farmer has been transformed into a businessman and the barn has become a factory." Agricultural buildings have changed over the years as differing requirements have been imposed and new methods and materials have been developed. However, a close look at how the needs for crop and animal shelter were met by early farmers reveals a surprising number of ideas that are still valid today. A brief study of early barns should be interesting and worthwhile.



## EARLY BARNS

The design of the earliest barns was largely influenced by the labor and materials at hand. At first, only the very minimal requirements were met. The first settlers probably provided only shelter for themselves and their families, waiting until the first crops were harvested to construct the necessary storage. As a quick and easy way of getting that first storage, wattle and daub were sometimes used. (Wattle refers to small branches woven together to form a wall, and daub is the mud or plaster used to seal the surface.)

However, in the forested areas of the East, barns were usually constructed of logs supported on low stone piers. As farmers prospered, more stone was used for the walls of the first floor. Eventually the ends, and finally the entire barn, was constructed of stone. Stone barns were popular in the Pennsylvania area in the late 18th and 19th centuries.

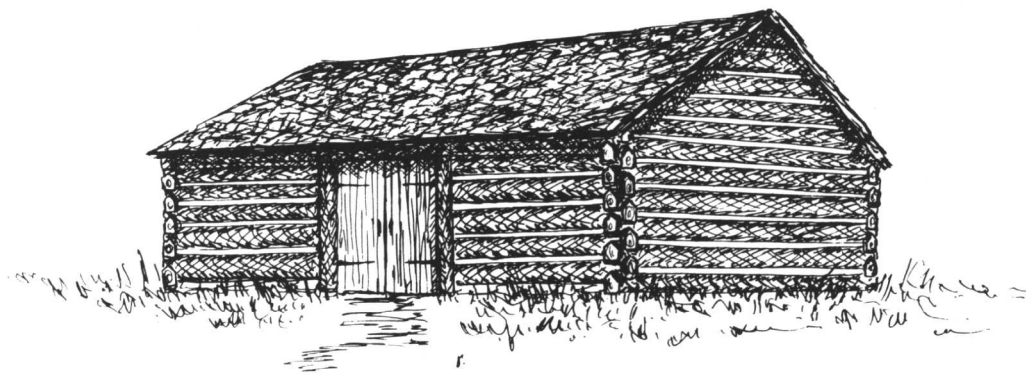


Figure 1-1. An early log barn.

The first roofs were usually covered with slabs of bark, although thatching was also employed to a limited extent, particularly in Canada. Some roofs were constructed with warped or scooped-out wooden slabs laid with the hollow sides alternately up and down and overlapped, much as tile is used today. This carried the rain water off with little leakage. However, shakes, which were thin slabs split from logs 3 feet or less in length, soon became the most common roofing material.

In the middle west and south-eastern areas of the country corn was the predominant crop and the earliest buildings were log corn cribs. As hay became more important, a mow was constructed over two or more cribs. Frequently the mows were cantilevered well beyond the crib walls.

In the middle of the 19th century, as the pioneers pushed west, sod