Chapter 9
Building production

INTRODUCTION

Building production is the organization and management of the plans, equipment, materials and labour involved in the construction of a building, while at the same time complying with all codes, rules and contractual stipulations. The procedure should be designed to run efficiently to keep costs low and to allow returns on the investment to be realized as early as possible.

While many topics included in this chapter, such as standardization, organization of building works carried out by a contractor, tendering, contracting, inspection and control and progress charts, may have limited relevance for small-scale building projects on African farms, it is felt that an engineer will need some knowledge of these topics when tackling work involving the construction of communal and central facilities for agricultural production and services and medium- to large-scale rural buildings.

The costs of rural buildings such as animal housing and stores for produce can be expected to be repaid in terms of increased production, improved animal health, reduced storage losses, increased quality of produce and more efficient work performance. Other buildings such as dwellings are expected to be worth their costs mainly in terms of the standard of space, environment, convenience, construction and appearance they provide.

The term ‘costs’ in this context means costs over the whole life of the building, including operating and maintenance costs, as well as an annual portion of the initial cost of construction. It also includes the costs of building materials and construction labour, and fees paid to consultants, architects and legal advisors, as well as interest on capital and any loss of production incurred during the construction phase.

Building planning is thus concerned with economic building rather than with cheap building, i.e. with providing the required standard of facilities at the lowest cost. It should be noted that costs include not only cash payments but also the value of materials and work provided by the farmer and the family, because these are resources that could have been used for alternative activities at the farm to generate income or produce food.

Most methods for construction costing and economic feasibility studies assume that resources employed for the construction, as well as the benefits of the finished structure, can be valued in a convenient monetary unit. Subsistence farmers are part of the monetary economy to only a limited extent, so it is difficult to put a fair price on material and work supplied by them for construction at their farms, or to correctly value the benefits of the structure.

There is a national interest in the efficient use of the resources invested in buildings. Governments express their minimum demands in the form of building regulations, codes and laws.

A farmer employing an engineer to design a building, a contractor to construct it and suppliers to deliver materials will expect delivery of work and goods to the standard and price stipulated in the agreement. For later reference it is common to formalize the agreement in a contract that makes reference to drawings and specifications for the structure and to general specifications. Inspections and controls are carried out to ensure compliance with the agreement.

THE BUILDING PRODUCTION PROCESS

The building production process begins when the farmer starts to seriously consider investing in a structure and ends only when the finished building is in use. The process is divided into stages that follow in logical sequence. Each stage is terminated by a decision. Table 9.1 gives an outline plan of work for the building production process.

In small projects where the farmer performs virtually all tasks involved, it may not be necessary to follow the chart in detail. Nevertheless the same procedural basics and logical order should be followed. During the initial planning stages, the costs are low compared with the importance of the tasks involved. The high costs involved in correcting errors once site operations and construction are under way can be avoided if time is spent working out a good, functional design that is technically and economically sound.

METHODS OF CONSTRUCTION

The methods of constructing rural buildings refer to the way in which units and components of the building structure are produced and assembled. The manner of organizing this process differs from region to region and depends on the level of technology and the materials available. The operations involved in the construction of rural buildings of traditional designs are familiar to most rural people in Africa, and small buildings on farms are usually constructed by the farmers and their families.

TABLE 9.1
The building production process

Stage	Substage	Tasks to be done	People directly involved	Result of work	Decision to be reached
Briefing	Inception	Investigate different alternatives for investments and development of the farm now and in the future. Alternatives to finance the investment. Suitability of conditions for different enterprises	Client, agricultural economist, various specialists as required for technical briefing	Investment plan Development plan	Choice of investment alternative. Appoint farm building engineer
	Feasibility	Carry out studies of user requirements, site conditions, requirements from authorities, functional and technical requirements and cost	Client, farm building engineer, various specialists as required for technical briefing	Feasible, alternative sets of functional and technical requirements with indication of their cost	Choice of functional and technical requirements
Sketch plans Alt. A	Outline proposals	Develop brief further. Roughly sketch alternatives for the general approach to layout, functional planning, design and construction. Approach authorities	Client, farm building engineer, various specialists as required to develop the brief	Alternative rough sketches for general outlines with indication of their cost	Choice of general outline
	Scheme design	Complete the brief. Complete the functional planning of the layout. Preliminary construction design and cost calculation. Obtain outline decision from authorities	Client Farm building engineer	Alternative outline proposals for construction design with indication of cost. Complete brief and functional layout	Choice of construction design. Preliminary decision to produce the building
Sketch plans Alt. B	Standard drawings	Develop and complete the brief. Collect drawings from reliable sources. Study the drawings and evaluate them regarding the functional and technical requirements	Client Farm building engineer	Alternative standard layouts	Choice of drawing set. Preliminary decision to produce the building
Brief should not be modified after this point					
Final design	Detail design	Full design of every part and component of the building. Complete cost checking of designs. Final decisions from authorities	Farm building engineer. Assistance from specialist engineers might be required in large and complex projects	Complete set of drawings, technical specifications, functional instructions and an accurate cost estimate	Final decision to produce the building
Any further change in location, size, shape or cost after this point will result in abortive work					
Working drawings	Production information	Preparation of final production information i.e. drawings, schedules and specifications regarding production methods and assembly and installation instructions. Prepare a time schedule for the production of the building	Farm buildings engineer. Assistance from a specialist might be required in large and complex projects	Production information. Time schedule	Detailed decision to carry out work
Purchase	Bills of quantities	Preparation of bill of quantities and tender documents	Farm building engineer (sometimes specialist assistance required)	Bill of quantities Tender documents	Select persons and firms to be invited for tendering
	Tender action	Evaluate and compare tenders and quotations after having put costs to exceptions and additions in the tenders and quotations. Draw up and sign contracts	Client Farm building engineer Contractor	Contract with contractor and suppliers	Select contractor and suppliers. Contractor may contract subcontractors

TABLE 9.1 *(continued)*
The building production process

Stage	Substage	Tasks to be done	People directly involved	Result of work	Decision to be reached
Site operations	Project planning	Hire labour, provide tools, prepare access road to site, put up temporary stores and sheds, clear the site, prepare stockpile areas and set out the building	Contractor	Site prepared for actual construction activities	
	Operations on site	Construction activities. Delivery of materials. Technical controls and inspections. Site meetings, accounts and economic control	Contractor Farm building engineer Client	Finished building	Decision on alternatives, when operations do not or cannot proceed according to the plans
	Completion	Technical inspection on completion. Correction of errors, defects and short-comings. Final technical inspection	Contractor Client Farm building engineer	Complete building Responsibility for the building transferred to client	Acceptance of the quality of the work carried out by the contractor
Post-construction	Entry into service	Study instructions and learn how to operate equipment and installations in the building. Develop smoothly running production work routines	Client Farm workers	Effective agriculture production involving the building	
	Guarantee	Investigate and inspect hidden defects, errors and shortcomings as they show. Inspection at the end of the guarantee period. Action for measures as required following the above inspections. Calculate final investment cost	Contractor Client Farm building engineer Farm workers	Building without hidden defects and shortcomings	Acceptance of work at the guarantee inspection. Responsibility for defects
	Feedback	Analyse technical and functional performance of the project. Analyse job records from site operations. Analyse costs	Farm building engineer Contractor Client	Recommendations for the design of similar future projects	

However, where new methods of construction, materials or layouts have been adopted, as well as where there is an increase in the size of the project, the assistance of trained artisans will usually be required. Self-help projects for the construction of communal facilities such as village stores must be accompanied by a training programme for the people involved. Where most of the construction is done by employed building workers, three different contemporary building methods can be distinguished – traditional; post traditional and system building.

The traditional method of constructing farm buildings is increasingly being replaced by post-traditional methods and, to some extent, by system-building methods. This rapid adoption stems from the marketing of modern building products by the materials manufacturing industry. The change has also been promoted by a rapid rise in population, which has led to a scarcity of traditional materials such as thatch.

Traditional buildings

In traditional buildings, the forms of construction have been developed by the traditional building trades, particularly walling, roofing, plastering, carpentry and joinery. This method is a process of combining many small units. Most of the fabrication and assembly takes place at the site and usually at the position that the completed structure is to be located.

Within each tribal culture, traditional buildings result in structures that are similar but differ slightly, depending on the specific requirements and site. Owing to the limited range of materials and forms of construction used, the craftsmen are familiar with the content and order of operations in their own trade and know their relationship to operations in other trades so well that they carry it out with a minimum of detailed information.

The traditional craft-based building method is flexible and able to accommodate variations in market demand for the work of craftsmen more readily and inexpensively than methods based on highly mechanized factory production. This is because production is carried out by the craftsmen and there is little investment in equipment, especially mechanical equipment, and factory buildings. However, the proportion of skilled labour required at the site is fairly high.

Post-traditional building

The post-traditional or conventional method of building mixes traditional and new forms of construction, involving both the old crafts and newly developed techniques based on new materials. To some extent traditional building has always been in a state of change, but the introduction of Portland cement and mild steel has made it feasible to construct large and complex buildings, and this has led to the need to organize the construction process efficiently.

The amount of on-site fabrication has been reduced by the introduction of prefabricated, factory-produced components, especially in the field of joinery and carpentry (windows, doors, cupboards, roof trusses, etc.). Reinforced concrete and preformed steel lend themselves to off-site fabrication of parts, followed by their assembly on site. Post-traditional building differs from traditional building mainly in terms of the scale of the work carried out and the use of expensive machinery for many operations.

The use of prefabricated, standardized components reduces the amount of skilled labour, but at the same time reduces the freedom of the designer in meeting varying design requirements. The scale of operation makes it necessary to pay greater attention to planning and organization of the work to ensure that material and labour are available in a continuous flow, that the mechanical equipment is used efficiently, and that the construction can proceed smoothly. It is therefore necessary to consider production operations during the design stage.

System building

System building is a method under which most of the building's component parts are factory-produced and site-assembled. The main advantages of system building are the possibilities for efficient factory production of large numbers of similar building elements and the reduced period of time necessary for assembly at the site. A disadvantage of this method is the high level of accuracy required for setting out and for foundation work because the nature of the components and the principles of the system are such that mistakes are difficult to correct during the assembly process.

The components (e.g. wall, floor, ceiling and roof elements) are usually related to a specific building type, such as houses, schools or warehouses, or to a restricted range of types. The design of buildings produced by this method is inflexible and limits the possibility of adjusting to specific requirements at a certain site or to a local building tradition. The building components may, for example, be produced for only specific dimensional measurements. For example, if prefabricated wall elements are 3.6 metres long, then the building length must be a multiple of 3.6 metres.

Components of one system will not ordinarily fit with components of other systems, a situation referred to as a 'closed system'. On the other hand, an 'open system' allows each component to be interchanged and assembled with components produced by other manufacturers. In order to keep the variety within acceptable limits for mass production, such a system must operate within a framework of standardization of the main controlling dimensions, e.g. floor-to-ceiling height of wall elements.

PREFABRICATION

Prefabrication is the manufacture of building components either on-site (but not *in situ*) or off-site in a factory. The use of prefabricated components can reduce the need for skilled labour at the site, simplify construction by reducing the number of separate operations, and facilitate continuity in the remaining operations. However, prefabrication is not necessarily time-saving or economical in the overall construction project. For example, the use of prefabricated lintels may save formwork and result in continuity in the bricklaying work, but could be uneconomical if a lifting crane is required at the site to place them, when it is not required for any other purpose on the job.

On-site prefabrication

On-site prefabrication may be an advantage where a number of identical components such as roof-trusses, doors, windows, gates and partitions are required. Once a jig, mould or prototype has been made by a skilled craftsman, a number of identical components can be produced by less-skilled labour, e.g. the farmer could do this job when there is time available during the off-season. Prefabrication of such items as roof-trusses also makes for more convenient and effective production than construction *in situ*.

It is advantageous to prefabricate some concrete components. Components for elevated positions require simpler formwork if cast on (or in) the ground so that the soil can be used to support the formwork. Although prefabrication eliminates the waiting time for concrete components to harden sufficiently for subsequent on-site operations to continue, the weight and size of concrete parts may make prefabrication impractical.

Local production by farmers of adobe bricks, burnt bricks, soil blocks, etc. is not normally referred to as prefabrication, although similar planning and organization are required for the production of these units as for the production of prefabricated building components.

Off-site prefabrication

Factory production of components requires capital investment in machinery and premises, a high degree of work organization, standardization and a steady demand for the products. Building components that can be produced economically in a factory essentially fall into three categories:

1. Those that have a high degree of standardization and are in great demand, making mass production,

utilizing the greater efficiency of modern factory production, feasible, e.g. bricks, blocks, pipes, windows, doors and building hardware.
2. Those that incorporate materials or finishes that are exclusively or more efficiently produced using factory-based techniques, e.g. metal components, plastic items, galvanized items and baked-paint finishes.
3. Those that make use of new factory-based techniques and machines, e.g. laminated-wood beams, pre-stressed concrete beams and insulated sandwich panels.

Factory production is relatively inflexible because large runs of any one component are essential for economical operation. The mere transfer of a simple operation from a site to a factory will not in itself reduce costs; on the contrary, it may increase them. This is particularly true for components for rural buildings because the demand for them originates from a large number of scattered construction projects, resulting in high transportation and distribution costs. Therefore many factory-made components used in rural buildings will have been designed primarily for other purposes.

DIMENSIONAL COORDINATION AND STANDARDIZATION

In order to limit variety in the size of similar components, to facilitate their assembly at the site and to make them interchangeable between different manufacturers, building components are manufactured in standardized dimensions based on an accepted system of dimensional coordination. Such preferred dimensions are given in standards, together with specifications for minimum technical performance requirements.

As the experience gained in factory production of components increases, the technique will be applied to components of increasing size and complexity (e.g. wholly finished wall elements) and this will increase the need for dimensional coordination. One system of dimensional coordination uses the international basic building module of 100 millimetres. The reference system establishes a three-dimensional grid of basic modules, or very often multimodules of 300 millimetres, into which the components fit.

The modular grid does not give the size of the component but does allow space for it. In order for the component to fit correctly, it will always be slightly smaller than the space allowed for it. The system must allow for some inaccuracy in the manufacturing process

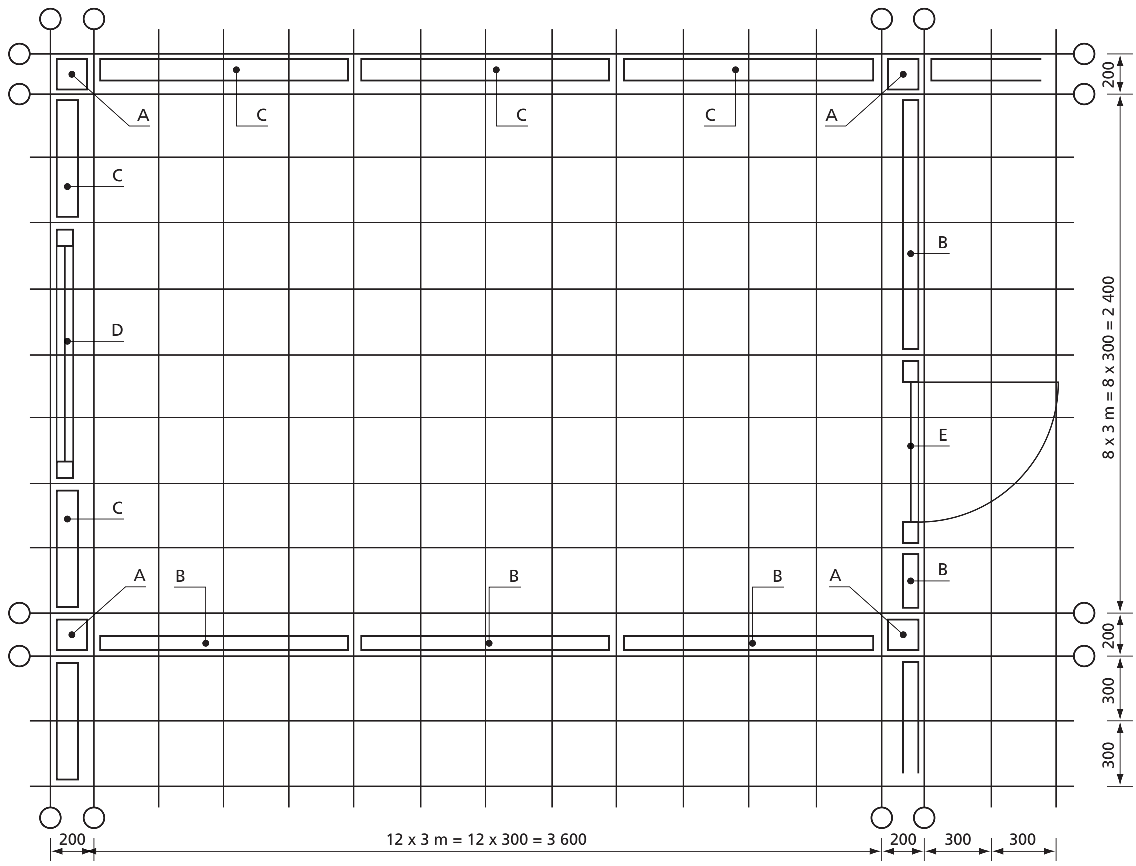

Figure 9.1a **Grid of 3M multimodules between zones of 200 mm allowed for load-bearing columns (A). Building components such as partition components (B), external wall components (C), windows (D) and door sets (E) are manufactured in sizes that are multiples of the 3M multimodule.**

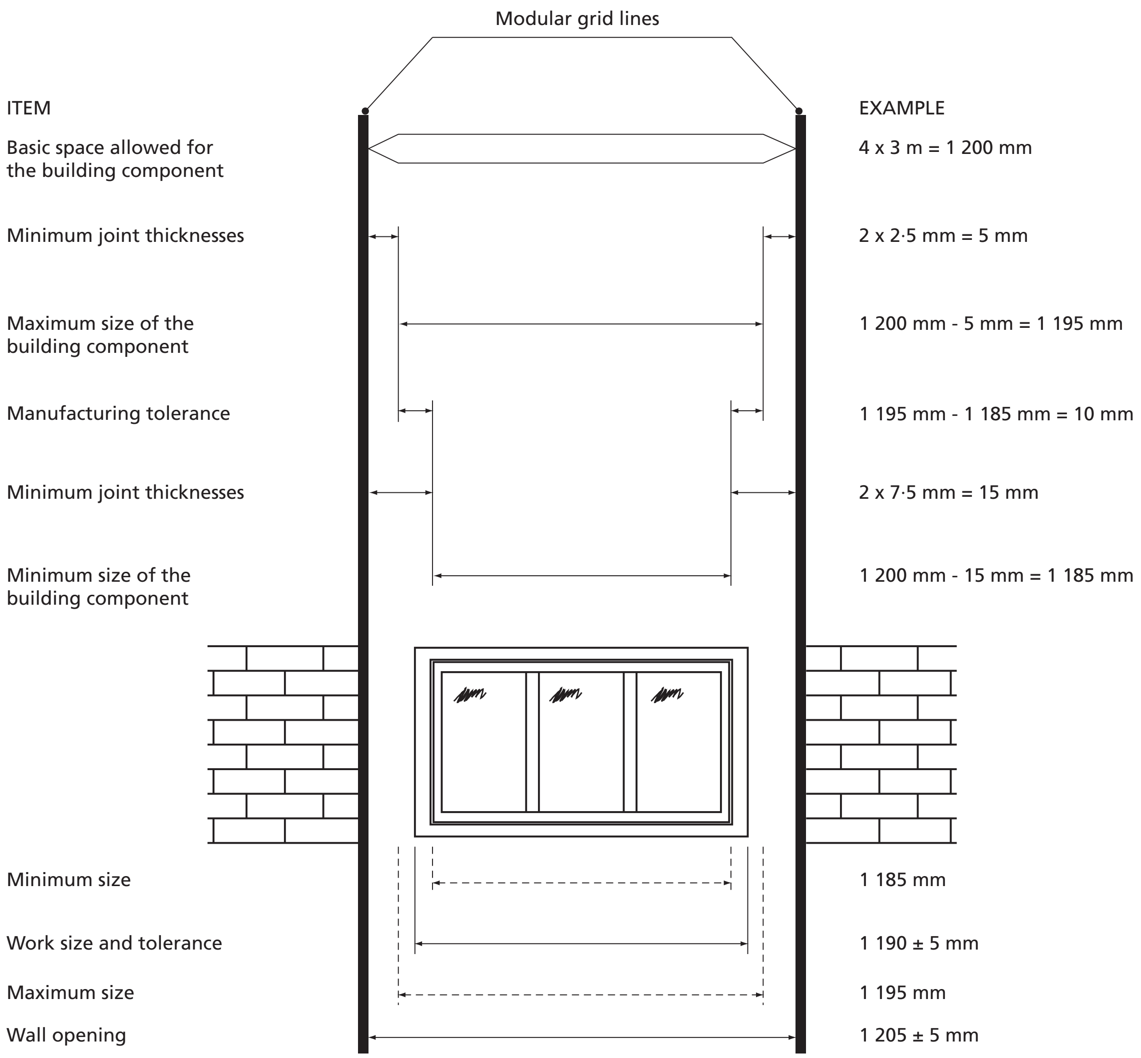

Figure 9.1b **Relationship of basic size, work size, manufacturing tolerance and joint thickness (*Note that tolerance and joint thickness are not to scale.*)**

and changes in size owing to changing temperature and moisture conditions.

This is expressed as a *tolerance* in size. For example, a window that is allowed a basic size of 1 200 mm for its width is produced with a working size of 1 190 mm and a manufacturing tolerance of 5 mm, which is expressed as 1 190 ± 5 mm. The actual dimension of a window delivered to the site would be somewhere between 1 185 mm and 1 195 mm. The joint would be designed to take these deviations into account.

Modular-size concrete blocks are 290 mm long and modular format bricks are 190 × 90 × 40 or 90 mm actual size to allow for 10 mm mortar joints and plaster. The actual size of openings will then be 1 220 mm. In this process the designer has a responsibility to specify tolerances that can be achieved with available craftsmen and factories.

It will be easier to fit factory-produced window and door casements, which are made to standard modular sizes, if these sizes are also used when bricks and blocks are manufactured locally. The common brick size of 215 × 102.5 × 65 mm allows for laying four courses to 300 mm vertically and four brick lengths to 900 mm horizontally, if 10 mm joints are used.

BUILDING LEGISLATION

In urban areas, government authorities issue building regulations to ensure the safety, security and welfare of those who use the buildings and to make maximum use of the scarce resources available for building construction. Typically, building regulations cover subjects such as building materials, structural integrity, fire precautions, thermal and acoustic insulation, ventilation, window openings and stairways, as well as drainage and sewage disposal. Building regulations may state minimum functional requirements, such as room height and space, for specific types of rooms.

Additional legislation applicable to buildings may be found in the public health act and public roads act. The building regulations and other legislation are statutory, i.e. they must be followed as far as they apply. The local authority ensures that the legislation is complied with through its building inspector, health inspector, etc. However, the authorities will sometimes issue guidelines for building, in addition to the regulations. These are mere recommendations and the designer may diverge from them if there are good reasons.

Building regulations do not normally apply to buildings outside urban areas, but there may be instances where other legislation is applicable, for example, where a farmer wants to connect to a main water supply or a main sewer or to run a drain under a public road. Therefore it is wise to contact the local authorities about any new building proposal or major alteration to an existing building. If local authority approval is necessary, copies of drawings and specifications will have to be submitted for its advice and approval.

CONSTRUCTION COSTING

Throughout the building production process, costs will have a major influence when choosing between alternative designs. An excessively high cost may even cause the whole project to be abandoned. In the initial stages, when rough sketches are evaluated, general guideline costs based on building area or volume may be sufficient. In the final design stage, when the farmer has to decide whether or not to proceed with construction, a more detailed cost estimate based on a simplified bill of quantities is usually prepared.

A contractor will need the most accurate cost estimate based on a bill of quantities, as the quotation should be low enough to be competitive but still generate a profit. On large projects, the bill of quantities is also used to determine interim payments for work that has been completed.

Quantity surveying

The objective of quantity surveying is to provide an accurate bill of quantities, which is a list of the amounts of all materials and labour necessary to complete a construction project. In the simplified version, supplied by the designer with the final design documents, the labour requirement is not detailed. Sufficient accuracy for the purposes of this bill can be obtained by including labour as a lump sum, or as the number of hours or days of work, or as a percentage of the building material cost.

A bill of quantities for a standard drawing often excludes such operations as site clearance, excavation and fill, and external works, because such quantities may vary greatly from one site to another and can therefore be difficult to assess accurately at the time the drawing is completed. Indeed, the bill for a standard drawing may be a mere list of materials, perhaps with a rough estimate of labour added.

To avoid mistakes or the omission of any item, sophisticated methods have been developed for quantity surveying of large-scale projects. As rural buildings are normally smaller and far less complex, a simplified procedure will be adequate. Many rules of thumb or conversions have been developed to take into account such factors as cutting waste, differences between nominal and actual sizes, and breakages.

Taking-off

The objective of taking-off is to produce a detailed list of all materials and work. The quantities are assessed on the basis of detailed project drawings and specifications and listed, as far as possible, in the order that building construction will proceed. The first items are site clearing, excavation and foundations and final items are finishings and external works.

The dimensions of each item are obtained from the drawings and then the quantity is calculated in the units in which the item is customarily sold or priced. For example, excavation or fill, concrete, mortar and water would be in cubic metres, aggregates in cubic metres or tonnes, cement and lime in numbers of bags, and many things such as bricks and blocks, windows and doors, building boards and roofing sheets in numbers of units. Sawn timber is listed as the number of pieces of a specific size or, where that is unnecessary, total linear or volume quantities. Round timber is listed as the number of units of a specific cross-section and length.

A particular item that occurs in several places in a building can be noted each time it occurs or the number of units can be totalled in one place. One way of ensuring completeness is to tick off each item on the drawing as it is listed.

Assessment of labour

Detailed labour requirements to complete the type of construction commonly used in farm buildings may be difficult to find in published sources. This is because the contractors, who have the best knowledge of such data, use them as a means to compete for tenders. Also, most construction companies involved in rural building are too small to employ a quantity surveyor who could collect the data. Data published by quantity surveyors' or building contractors' associations tend to emphasize urban types of construction.

Rough estimates of the labour requirement needed by the designer of rural structures must be obtained through experience and by analysing a number of projects similar to the one at hand. Where the farmer and the farm labourers construct a building, it is to be expected that the labour requirement will be higher than when skilled construction workers are used. However, farm labour is available without any extra cash payment and there may be few alternative uses for it during the off-season.

Bill of quantities

The items for a bill of quantities are normally grouped together under headings for either the main operations (excavation, foundations, walling, flooring, roof

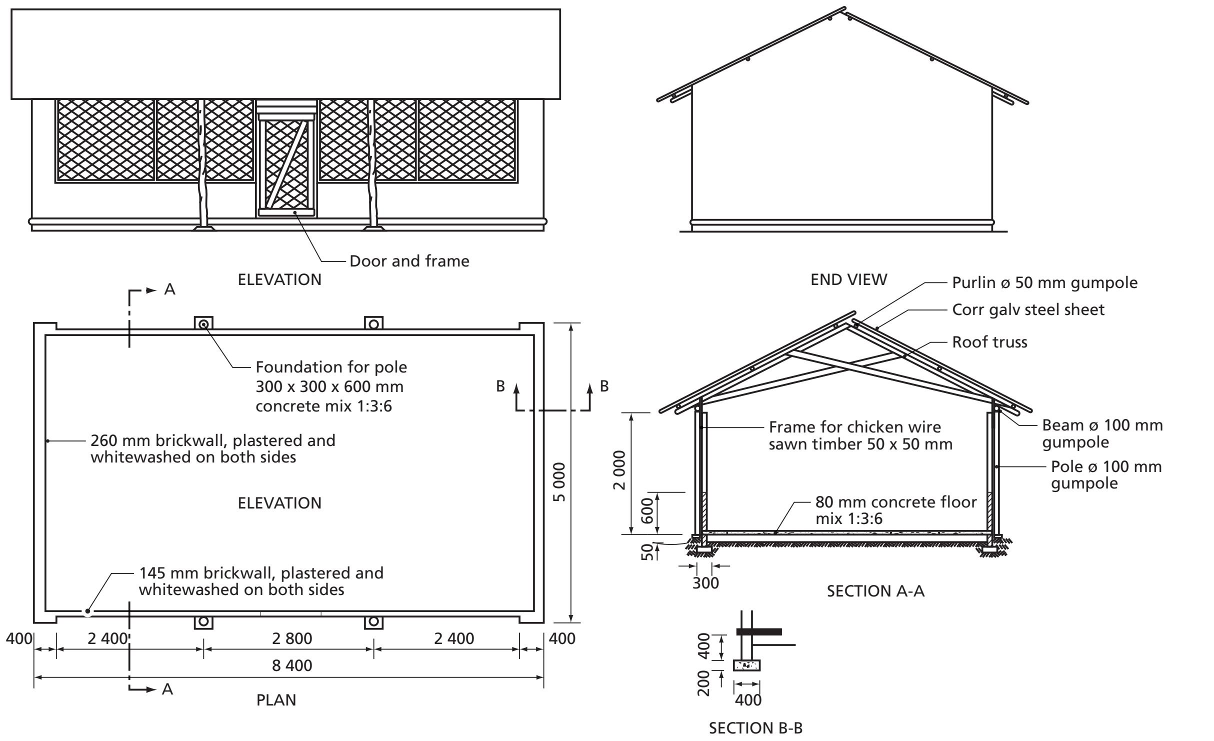

Figure 9.2 **Main drawing for a poultry house**

structure, roofing, finishing and external works) or the trades involved (earthwork, masonry, concrete work, carpentry and painting). Work normally carried out by subcontractors (wiring, plumbing, installation of equipment and furnishing) is listed separately.

The total quantity of each material or volume is transferred from the taking-off sheets to the appropriate heading in the bill of quantities and, while doing so, a percentage allowance for waste and breakage is normally added. The percentage added will depend on the type of material or volume but is often taken to be between 5 percent and 15 percent.

To keep a record of the items, they should be ticked off on the taking-off sheets as they are transferred to the bill of quantities. Labour may be listed under each operation or trade but, in the simplified bill, it is given as a lump sum at the end.

Example:

Prepare a bill of quantities for the poultry house illustrated in Figure 9.2. Start with taking-off.

Footing and foundation for poles, concrete 1:3:6

Footing, end walls	2 × 5.8 × 0 4 × 0.2	0.93 m³
Footing, side walls	2 × 7.6 × 0.3 × 0.15	0.68 m³
Foundation for poles	4 × 0.3 × 0.3 × 0.6	0.22 m³
Waste and spill 10%		0.18 m³
		2.01 m³

The amount of ingredients can be calculated using the figures in Table 5.13.

Floor

Base layer of gravel	8.4 × 5.0 × 0.15	6.30 m³
Sand for blinding	8.4 × 5.0 × 0.02	0.84 m³
Concrete (5% waste)	8.4 × 5.0 × 0.08 × 1.05	3.53 m³

Bricks

Area of sidewalls,	
(0.6 + 0.2) × (2.4 + 2.8 + 2.4) × 2	12.16 m²
minus door opening 0.6 × 1.00	0.6 m²
	11.56 m²

Number of standard bricks
(0.215 + 0.010) × (0.065 + 0.010) = 0.017 m² per brick
11.56 × 1/0.017 = 680 bricks

Area of gable walls	0.40 × (2.0 + 0.4) × 4	3.84 m²
	5.0 × (2.25 + 0.4) × 2	26.50 m²
	5.0 × 0.5 × 1.34 × 2	6.70 m²
		37.04 m²

Number of standard bricks
(0.1025 + 0.010) × (0.065 + 0.010) = 0.0084 m²/brick,
37.04 × 1/0.0084 = 4 410 bricks

Number of bricks, 680 + 4 410	5 090
Waste and breakage 15%	765
Total number of bricks	5 855

Mortar, composition 1:1:6

Sidewalls 11.56 m² × 0.025	0.29 m³
End-walls 37.04 m² × 0.051	1.89 m³
Waste and spill 15%	0.32 m³
	2.50 m³

Plaster, cement plaster 1:5

Plaster thickness 10 mm	
(11.56 + 37.04) × 2 × 0.01	0.97 m³
Waste and spill 15%	0.15 m³
	1.12 m³

The amount of cement and sand for the mortar and plaster can be calculated using the values in Table 5.17.

Wooden posts

Gum-poles 3.0 m, diameter 100 mm	4 pieces
Wood preservative	2 litres

Trusses

Gum-poles 4.0 m, diameter 100 mm	4 pieces
Bolts 110 mm long, diameter 8 mm	10 pieces
Bolts 200 mm long, diameter 8 mm	2 pieces

Purlins

Gum-poles 3.0 m, diameter 50 mm	18 pieces

Roofing

Corrugated steel sheets are laid in two rows on each side and the covering width is 533 mm per sheet. The length of the roof is 9 metres.

9 000/533 = 16.9

i.e. 17 sheets are required per row, or a total of 68.

Roofing nails

6 nails per m² × 68 m² = 408. As each kilogram of nails holds about 97, the requirement will be 4.5 kilograms.

Netting wall

Frame, timber 50 × 50 mm , including 10% waste	51.8 m
Chicken wire 1 800 mm wide	16.0 m

Door

Casement, timber 75 × 75 mm, including 10% waste	5.5m
timber 25 × 100 mm	2.0 m
Door frame, timber 25 × 100 mm	7.7 m
subtotal timber 25 × 100 mm	9.7 m
10% waste	1.0 m
Total timber 25 × 100 mm	10.7 m

Nails

Staples for fixing the chicken wire	1 kg
Wire nails 75 mm	1 kg
Wire nails 100 mm	1 kg

Whitewash

Whitewash is required for 97 m²

When all requirements are calculated, the amounts are included in the bill of quantities as follows:

TABLE 9.2
Bill of quantities for poultry house (see Figure 9.2)

Item	Description	Unit	Quant.	Rate	Total
1.	Foundation, 2.01 m³ concrete, mix 1:3:6 (10 percent waste)				
	Cement	50 kg	9.0		
	River sand (0.88 m³)	tonne	1.3		
	Crushed stone (1.8 m³)	tonne	2.9		
2.	Floor, gravel (6.3 m³)	tonne	10.1		
	Sand (0.84 m³)	tonne	1.2		
	3.53 m³ concrete, mix 1:3:6 (5 percent waste)				
	Cement	50 kg	14.0		
	River sand (1.6 m³)	tonne	2.3		
	Crushed stone (3.2 m³)	tonne	5.0		
3.	Bricks (215 × 102.5 × 65 mm)	number	5 910		
4.	Mortar, 2.5 m³, mix 1:1:6 (15 percent waste)				
	Cement	50 kg	13.0		
	Lime	kg	250.0		
	Building sand (2.8 m³)	tonne	4.0		
5.	Plaster, 1.13 m³, mix 1:5 (15 percent waste)				
	Cement	50 kg	7.0		
	Building sand (1.3 m³)	tonne	1.8		
6.	Posts, gum-poles (3.0 m × ϕ 100 mm)	number	4		
	Wood preservative	litres	2.0		

TABLE 9.2 *(continued)*
Bill of quantities for poultry house (see Figure 9.2)

Item	Description	Unit	Quant.	Rate	Total
7.	Roof structure, gum-poles (4.0m × ϕ 100 mm)	number	4		
	Gum-poles (3.0m × ϕ 50 mm)	number	18		
	Bolts (110 mm × ϕ 8 mm)	number	10		
	Bolts (200 mm × ϕ 8 mm)	number	2		
8.	Roofing, corrugated galvanized iron sheets				
	(CS 8/76 × 2.0 m, 0.018 mm)	number	68		
	Roofing nails	kg	4.5		
9.	Netting wall				
	Sawn timber (grade 3) 50 × 50 mm	running metre	51.8		
	Chicken wire, width 1 800 mm,	metre	16.0		
10.	Door, sawn timber (grade 2)				
	75 × 75 mm	running metre	5.5		
	Sawn timber (grade 2)				
	25 × 100 mm	running metre	10.7		
	Hinges	number	2		
	Latch	number	1		
11.	Nails, staples	kg	1.0		
	Wire nails 75 mm	kg	1.0		
	Wire nails 100 mm	kg	1.0		
12.	Whitewash (97 m²)				
	Lime	kg	50.0		
	Sand	kg	10.0		
	Cement				
13.	Furnishings, feed troughs	number	4		
	Drinkers	number	4		
TOTAL MATERIAL COST					
14.	Transport cost for material				
15.	Earthworks, excavation to level	m³			
	Remove top soil	m³			
	Excavation for foundation	m³			
16.	Construction	man-days			
17.	External works				
18.	Contingencies				
19.	Supervision and contractors' overhead costs				
TOTAL COST					

Costing

As mentioned in the introduction to this section, it is necessary to continuously assess the building costs for a proposed structure throughout the planning stages of the building production process. Three levels of accuracy can be distinguished: general guidance cost, specific guidance cost and accurate costing.

In addition, costing is carried out during construction to ascertain how the project is progressing from a financial point of view and to determine any interim payments to the contractor.

In the post-construction stage, the actual cost of the project should be calculated so that a record can be produced that will enable future building work to be accurately costed.

Unfortunately this is often neglected by designers and builders of rural structures.

General guidance cost

In this case rough estimates, simply giving the scale of costs, are derived by experience and analysis of a number of other similar projects. For example, if the costs of a number of grain stores are assessed and in each case compared with the capacity of each store in tonnes, then a rough cost for grain stores can be estimated in terms of cost per tonne stored.

Hence an estimate can be given for a proposed new grain store if the capacity is known. Similarly, a building for dairy animals can be estimated if an average cost per cow is known from a number of different units.

Furthermore, for particular types of construction, it is possible to obtain average figures in terms of floor area. This type of estimate is based on a number of projects, some of which may not be directly comparable.

Specific guidance costs

By comparing similar projects, it may be possible to obtain reasonably accurate estimates before taking time to design the building and work out the bill of quantities. In this case, the costs of other buildings should be assessed in three components:

1. *Established costs*: costs that either have a fixed value or a uniform-unit value regardless of the size of the building. Examples are windows and doors.
2. *Variable costs*: costs that vary with the size of the building. As the length of a building grows, its total cost will grow but, at the same time, the unit cost may decrease so that even though a building is 50 percent longer the cost increase may be only 40 percent.
3. *Additional costs*: costs such as fees for consultants, architects, lawyers and accountants. Interest, insurance, fitting costs and losses should also be included.

Therefore, if a number of similar buildings are analysed, good estimates of each of these types of costs may be obtained and reliable specific guidance costs can be determined.

Accurate costing

This is done in conjunction with the bill of quantities. An accurate total cost of a job can be derived from the rate column in the final bill of quantities, together with the cost rate for each item. This requires each individual item of material, volume or labour to be costed.

However, for convenience and to facilitate the calculation of a quotation, many building contractors derive a cost per quantity of common types of construction. For example, a cost per square metre of concrete block wall will include the cost of the blocks, the labour to mix mortar, the cost of mortar materials and the labour required to lay the blocks. It may even incorporate a factor taking into consideration the average requirement of window and door openings and scaffolding.

However, costing with this degree of detail requires considerable information that can only be gained from experience and data that have been collected and analysed over a number of building projects. The unit costs will have to be reviewed continuously or be corrected with an index for building costs.

ECONOMIC FEASIBILITY

In addition to the actual cost of constructing a building, which must be considered in relation to the financial capacity of the farmer, the total annual cost of the building should be determined. When the annual cost is then compared with the expected increase in income or the saving in storage costs, it forms the basis for deciding whether or not the new building is a worthwhile investment, i.e. it determines the economic feasibility of the building.

To derive the true annual cost of a building, a number of factors must be considered. These include the estimated life of the building, annual repairs and maintenance, interest on the investment, insurance and, in some countries, real estate taxes. With the possible exception of repairs and maintenance, these are 'fixed' costs that occur whether or not the building is used. Consequently it is important to plan carefully both the use of the building and the construction.

The building may be considered as a production cost, and the potential income from the enterprise housed in it must be sufficient to justify the cost of building. It should be stressed, however, that there may well be reasons other than economic ones for constructing a building. For instance, a dwelling cannot be justified in terms of profitability alone as aspects such as amenity and welfare considerations may outweigh other factors.

Building life (depreciation period)

Physical life

All building components have a limited life. After a time, materials will deteriorate to a point where they can no longer fulfil their function. While repair, replacement and maintenance can extend the life, eventually the overall deterioration becomes excessive.

The life span of a building is influenced by its design and construction. In general, more costly materials such as steel and concrete are likely to last longer than timber and other organic materials. The physical life of rural buildings may range from two to five years for the simplest structures and as much as fifty years or more for substantial ones. An average figure is between 10 and 20 years.

Economic life

Although a building may last for many years, it may cease to be economically sound at an earlier time for any of several reasons. It may be that the design has become obsolete and is not suitable for new mechanization; or perhaps it is too small because the farm has grown; or a new enterprise requires a new layout or interior partitions, but supports simply cannot be moved to accommodate the new requirements. General purpose buildings will therefore have a longer economic life than those built for a specific enterprise.

Write-off life

It is impractical to expect any enterprise to pay the full cost of a new building in the year immediately following construction. Therefore the capital cost of the building is allocated or depreciated over several years. The number of years is determined by the write-off life, that is to say, the number of years over which it seems feasible to spread the original cost, but never fewer than the duration of a loan. In addition, the write-off life must not exceed the estimated physical or economic life to avoid being in possession of a useless building for which the original cost has not yet been fully paid.

As economic conditions change rapidly, the risk of a large investment is reduced considerably if the depreciation can take place over a relatively short write-off period. Ten years is considered short, 15 to 20 years medium, and 20 to 30 years a long period. This means that a building that is still physically sound and economically practical after the depreciation has been completed can be considered an economic bonus for the farm.

For cost estimation, depreciation is usually calculated on a 'straight-line' basis, that is to say, equal annual amounts over the write-off life. The annual straight-line depreciation cost is the original cost of the building divided by the years of write-off life. There are a number of alternative methods for assessing depreciation, most of which result in higher costs in the early years and decreasing costs over the life of the building.

Interest

The cost of the money used to construct a building must be considered, whether the financing is by means of a loan or by cash at hand. If money is borrowed, the interest cost is obvious. However, if farmers invest their own money, they are foregoing interest income from a bank or the possibility of other investments. Consequently, interest is still a real expense and should be included as an annual building cost.

The interest rate used is either the rate actually being paid or the prevailing rate for mortgage loans in the area. The interest charge is assessed during the years of depreciation and, during that period, the amount invested (principal) is gradually written off, from the full cost at the start to zero at the end.

Therefore the annual interest charge is usually based on the rate, multiplied by the average investment (original cost divided by two, or the original cost and half the rate). It should be pointed out that both a long-term mortgage with equal monthly payments (interest plus principal) and compound bank interest will result in higher interest costs.

Repairs and maintenance

Although all buildings will require some maintenance, the cost will vary with the type of building, the climate and environment, the materials used in construction and the use of the building. Although the cost for repairs and maintenance will vary from one year to the next and generally increase with the age of the building, it is common practice to assume a uniform annual allowance throughout the life of the building.

It is typical to allow between 1 percent and 3 percent of the initial construction cost for repairs and maintenance. While this is true in a monetary economy, it may not apply in a subsistence economy.

Insurance and taxes

If an owner carries insurance on buildings to cover the risk of fire and other hazards, then the cost of that insurance is included as an obvious annual cost. On the other hand, if farmers choose not to take out insurance, they are in reality carrying the risk themselves and should still include an annual charge for insurance. Insurance will ordinarily range between 0.5 percent and 1 percent of the original cost.

In countries where an annual real estate tax is levied, the taxes must also be included as an annual building cost. Taxes will range from zero, where there are none, up to 1 or 2 percent of the original cost of the building.

Annual cost

The five principal components of the annual cost of a building have been discussed in some detail. A variety of situations produce a rather wide range in the annual cost figures. The greatest variation occurs in the write-off period. This is influenced by the life of a loan, the life of the building and, in some cases, simply the arbitrary decision of the farmer.

In the following examples, all the low-range values are combined, as are all the high-range values. It should be pointed out, however, that they may occur in any combination. A high depreciation cost and low maintenance or low interest is perfectly possible.

	Low	Medium	High
Depreciation	3.5 (29 years)	6.25 (16 years)	10 (10 years)
Interest*	3	5	7
Maintenance and repairs	1	2	3
Taxes	0	1	2
Insurance	0.5	0.75	1
Total annual cost as a percentage of the original cost	8%	15%	23%

*Note: The interest rate is halved, as ordinarily interest is based on the average value or one-half of the original cost.

Having determined a write-off life and the corresponding depreciation percentage, as well as prevailing values for the other costs, the total percentage is multiplied by the original cost of the building to obtain the annual cost. Next an estimate is made of the net income from the enterprise to be housed and the result compared with the annual building cost. The income should more than cover the building cost, allowing for a reasonable profit.

It should be noted that an existing building already has annual costs and that it is the *increased* cost of a replacement building that is compared with an *increased* income. If the plan is for an entirely new building to house a new enterprise, then the *total* annual building cost is compared with the *total* net income from the enterprise.

Cash flow and repayments

The annual cost for a building, as illustrated in the previous section, includes the capital cost in the form of depreciation as well as the carrying cost or interest.

If the farmer is fortunate enough to be able to pay all or most of the original cost of the building, then a comparison of annual building costs with income indicates the length of the period over which the farmer can expect to recover the investment. However, if the building project has to be financed largely by a loan, then cash flow and the ability to repay both capital and interest charges must be considered.

Any grantor of a loan will usually demand that repayments start immediately but, owing to the problems commonly experienced by farmers in starting up production in a new building, the earnings at this stage may be lower than expected. In the case of animal housing, the capital needed to purchase animals, feed and equipment is often larger than anticipated. The result may be insufficient cash during the first few years after the building has been constructed.

Even where a careful analysis has shown the enterprise to be profitable, that is to say, it has shown the expected average annual cost to be lower than the expected average income, the combined interest and principal payments on a long-term loan are likely to exceed the estimated average annual costs.

This makes it important to determine not only whether the cost of a new building can be justified, but also whether the necessary cash flow can be generated to cover both interest and capital repayments. While this is more of a business-management problem than a farm-structures problem, it is no less important to a farmer contemplating a new building.

ORGANIZATION FOR CONSTRUCTION OF SMALL BUILDINGS

In the case of farm structures, the future proprietor – the farmer – is normally much more directly involved in any repair or construction process than would be the case with a building in an urban area. Although the farmer may appoint an advisor to help with planning and design, employ a contractor or local craftsmen and take out a loan to finance the construction, the family's participation at all stages will normally be of great importance and serve to reduce the amount of cash necessary for the project.

Depending upon the level of self-involvement by the farmer, the family and any farm labour, and the way in which the construction is administered, four forms of organization can be distinguished: personal management; divided contract; general contract and turnkey contract.

Forms of organization

Personal management is a very common form of organization for repair work and construction of small- to medium-size rural buildings. The work is carried out by the employer (the farmer and the family), with the assistance of farm labourers and temporarily employed craftsmen. The employer may simply administer the work or participate in the construction work.

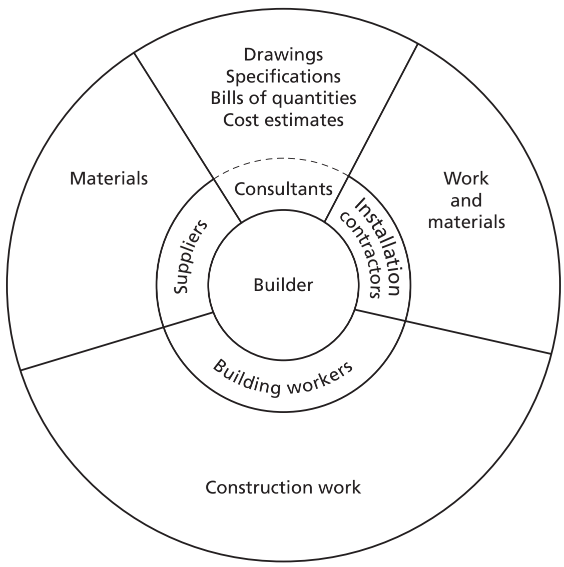

Figure 9.3 **Personal management**

A divided contract implies that the employer engages different contractors for the construction work and for installation and fitting work. This form of organization differs from personal management mainly in that the building construction work is carried out on a contract.

Self-involvement by the farmer can be arranged either by excluding some operations from the contract, such as earthwork and external work, or by giving the farmer some form of 'employee' status with the contractor. The latter is more easily arranged when a running-account payment system is used for the contract (see section entitled 'Forms of payment'). Building materials may be purchased by either the employer or the contractor. The contractor for the building construction work may be appointed to act as a coordinator for the various contracts.

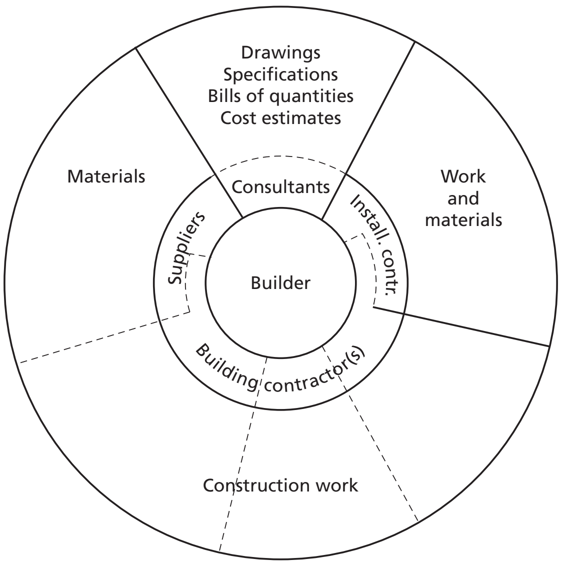

Figure 9.4 **Divided contract**

A general contract implies that the employer engages one contractor to carry out all the building construction operations. The contractor may in turn engage subcontractors to carry out work, such as fittings and installations, which the contractor lacks the skills or capacity to undertake. This form is uncommon for farm building construction, except for large projects.

A turnkey contract differs from the general contract in that the planning and design of the building is also included in the building contract. This form is very rare for rural building construction, except perhaps for completely prefabricated buildings in which the manufacturer serves as the contractor for erection.

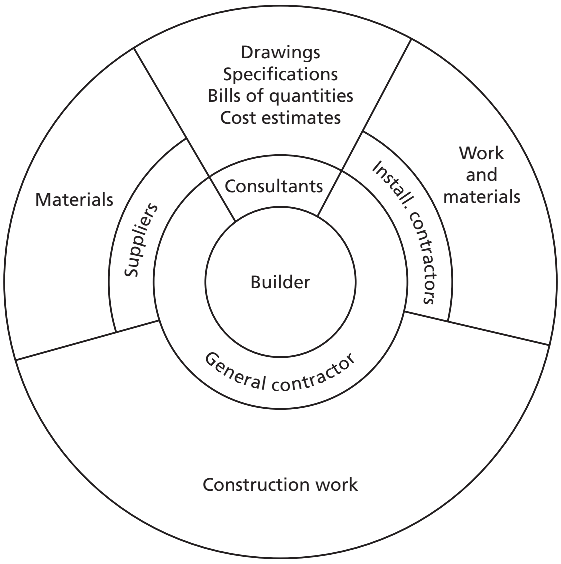

Figure 9.5 **General contract**

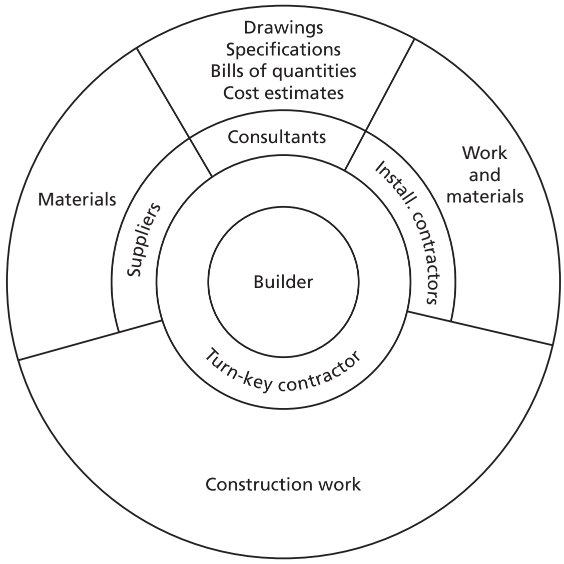

Figure 9.6 **Turnkey contract**

Forms of payment

The contract or agreement between an employer and a contractor may state that the payments for the contracted work will be made at a fixed price, with or without instalments for work completed, or on a cost-plus basis up to a ceiling figure, or with a running account for cost of materials purchased, plus an agreement on labour costs.

A fixed price is common for general and turnkey contracts, and is often used for divided contracts. The advantage of a fixed price to the employer is that the cost of the construction is known at an early stage. However, the contractor will require comprehensive documentation in the form of drawings and specifications to be able to give a quotation for a fixed-price contract.

Incomplete documentation will cause problems and frequent negotiations to decide on details and variations, usually involving additional expenditure. Therefore a running account is frequently used in cases where the documentation is insufficient or where it is difficult to make a satisfactory description of the work beforehand, as with repair and maintenance work. If a ceiling is placed on the running account, the employer will be guaranteed a maximum cost and will benefit, compared with a fixed price contract, should the work be less costly than the stated maximum.

TENDERING

The objective of tendering is to obtain proposals for construction work from different contractors and quotations for building materials from different suppliers. Competition between suppliers to submit the most favourable offer should result in a less expensive building for the farmer.

The tender procedure

When the farmer has decided to proceed with the proposed structure, the farmer and the advisors will prepare the tender documents, which usually comprise a letter of instructions, the necessary drawings and specifications and perhaps a bill of quantities, and will send them to various contractors and suppliers.

A contractor, or an estimator, will cost all building materials, volumes and labour and, after adding an allowance for supervision, overheads, insurance, contingencies and profit, will prepare a tender that is sent to the prospective employer in a sealed envelope.

During preparation of the tender, the contractor will visit the proposed building site to consider possible difficulties, in particular: access to the site and the need for temporary roads; storage of materials; type of ground; arrangements for siting any temporary office or welfare buildings; availability of labour in the area; arrangements for protecting the works against theft and vandalism. The contractor may also request fuller written documentation from the employer and, where subcontractors are to be employed, obtain tenders for their work.

A supplier of building materials or equipment will require less documentation and usually will not have to visit the site in order to prepare a quotation. The offer may or may not include transport to the site.

When the reply period specified in the tender instruction has expired, all the sealed envelopes containing the offers from the contractors and suppliers are opened. The contractors/suppliers may be invited to attend the opening of bids and be given names, prices and other relevant information contained in the offers. After careful evaluation of the offers, the most favourable, which will not necessarily be the cheapest, is accepted and a contract is prepared.

Methods of tendering

Open tendering: The prospective employer advertises in the press, giving brief details of the work, and issues an open invitation to contractors to apply for the necessary documents. The advertisement should state that the employer is free to select any or none of the bids that may be tendered. Tenderers are normally required to submit references and to pay a deposit for the documents, which will be returned on receipt of a serious tender. Open tendering is uncommon for rural construction work.

Selective tendering: Competitive tenders are obtained by drawing up a list of three to five serious contractors or suppliers in the area and inviting them to submit quotations. Normally the farmer and the advisor will know of a sufficient number of contractors who have the skill and experience to construct farm buildings and are also known for their integrity. Hence the lowest tender can usually be accepted.

Negotiated contracts are obtained by contacting one or two contractors or suppliers who have been found satisfactory in the past. The price for carrying out the work or delivering the material is negotiated until an agreement is reached. Negotiated contracts are also commonly used where the magnitude of the contract is not known at first, such as repair work, excavation in unknown ground, or where the tender documents are insufficient.

In such cases, the negotiation will normally aim at establishing reasonable task rates for a contract, with a running account. With a fixed contract, a contractor would have to safeguard against the unexpected and a large allowance for unforeseen expenditure would lead to a high contract price.

Evaluation of tenders

Quotations submitted to the prospective employer are likely to contain reservations, exceptions, additions and other conditions for the work or delivery of materials. A contractor may also suggest an alternative design or building method. If the letter of instructions for tender states that all such divergences from the tender documents should be priced separately, it will be quite simple to recalculate the tenders so that they are comparable. In other cases they will have to be costed by the employer.

The letter of instruction will normally ask the contractor to submit references from similar projects constructed in the past. For large projects, a bank reference and a performance bond are advisable. These should be examined to establish the contractor's practical and financial ability to undertake the proposed work.

CONTRACTS

A contract is a legal document signed by both parties before witnesses. The essence of a contract for construction work is the promise of a contractor to erect the building as shown on the drawings, and in accordance with the detailed specifications, in return for a specified amount of money known as the contract sum. A variety of standard forms are available for building construction contracts, but it would be desirable to develop a standard contract form specifically applicable to rural building construction.

If a bill of quantities is included in the documents attached to the contract, the employer will be responsible for any errors of measurement or shortcomings that occur in the bill. However, the selected contractor can be asked to check the bill and accept responsibility for it as being final. In the case of contracts without a bill of quantities, the bill is prepared by the contractor and any errors are then his responsibility.

A standard contract form may include the following information, but each clause in it should be studied prior to signing, and any clause that fails to meet the specific requirements of the project should be modified or deleted:

1. Names and addresses of employer and contractor.
2. List of all attached documents, i.e. drawings, specifications and bill of quantities.

3. Amount of the contract sum.
4. Starting date and completion date.
5. Weekly penalty to be paid should the contractor fail to complete the work on time. (Not always included.)
6. Directions for the employer to make a fair and reasonable extension of time for completion should the work be delayed through any cause beyond the contractor's control.
7. Directions for the contractor to comply with all applicable rules and regulations issued by local authorities.
8. Directions for the contractor to arrange regular site meetings between the contractor and the employer and to keep a diary detailing progress of the work. (Not always applicable.)
9. Directions for the contractor to obtain the employer's approval before any work is executed that diverges from the drawings or specifications, in particular where the variations involve additional expenditure.
10. Reference to a list of any building materials and equipment that will be supplied by the employer.
11. The extent of the contractor's responsibility for any liability, loss or claim arising during the execution of the contract work, whether for personal injury or loss or damage to property.
12. Insurance requirements for the contractor.
13. Statement requiring the contractor to pay, at his own expense, for any defects or faults arising from materials or workmanship that are not in accordance with the drawings and specifications.
14. Statement requiring the contractor to pay, at his own expense, for any hidden defects or faults that may appear during a specified guarantee period, usually 3 to 12 months, after the contract work has been completed.
15. Payment schedule, describing the percentage of the contract price to be paid on completion of each step.
16. Guarantee amount: normally about 10 percent of the contract sum is withheld until the guarantee period has expired or all defects are corrected, whichever is later.
17. Procedure for resolving disputes between the contractor and employer, e.g. that they shall be referred to arbitration for a binding decision.
18. The signatures of the contractor, the employer and witnesses.

SPECIFICATIONS

The specifications document supplements the drawings. The drawings should describe the geometry, location and relationships of the building elements to one another. The specifications set out quality standards for materials, components and workmanship that cannot be written on the drawings.

For example, if the drawing states that concrete Type 1 should be used for a floor, the specifications may set out a mixing ratio, quality standards for aggregate and water, compaction and curing practices, and quality standards for joints and finish.

Minimum requirements for capacity and reliability of equipment, as well as calculations relating to design, insulation, ventilation, etc., may be included as appendices. While in small projects, which are typical of numerous rural structures, many of the specifications may be included on the drawings, in large-scale projects the specifications may run to scores of pages.

General specification

As much of the information in the specifications will be similar from one project to another, it can be generalized to apply to most buildings. In many countries, the building industry or government agencies have therefore developed a 'General specification for building works'. This normally covers the majority of materials, types of construction, fittings, furnishings, etc. for the types of buildings and other structures built in urban areas. While some of the information included may also apply to rural structures, in general a list of specifications will need to be developed for the particular structure.

The advantages of using a general specification are that all parties are expected to have access to a copy and that they are familiar with the quality standards required in the various sections. Any planner/designer preparing specifications for a building may refer to the section numbers in the general specification without repeating the text of those sections. In addition, particular specifications that supplement, amplify or amend the provisions of the general specification will be required for each specific project.

To avoid confusion arising from discrepancies between the various building documents, the drawings normally prevail over the general specification, particular specifications override both drawings and the general specification and building code regulations override all other documentation.

Occasionally, when the government is the employer or when buildings are financed with government loans or subsidies, the general specification is considered statutory, but in all other cases its provisions can be used and amended as and when required.

PROGRESS CHART

A progress chart is a schedule, used to coordinate the sequence and timing of the operations in a building production process. It helps to ensure a timely supply of manpower, materials, equipment, machinery and subcontracted services by providing information on which dates and in which quantities they will be required, so that they can be ordered in good time. It can also be used to monitor the progress of the work and ensure compliance with the schedule.

The chart is often divided into three parts:

- The first part is produced by the farmer or an advisor and covers all work up to the time site operations start. It includes the sketches, any applications to authorities, final working drawings, tendering and ordering.
- The second part is normally produced by the contractor and includes all site improvements and construction operations (see Figure 9.7).
- The third part covers the start-up of production in the building and is developed by the farmer and advisors.

The preparation of a progress chart starts with listing all operations and their expected duration and identifying operations that *must* follow each other in sequence.

In the second step, a chart is developed showing the input of labour, machinery and equipment for various operations until the completion date is met. While doing this, it will be noticed that there is a sequence of operations called *critical operations* that must follow each other in a specific order and together determine the total time required to carry out the work.

In the third step, the requirements in terms of resources, in particular labour, and to a lesser extent machinery, are adjusted so that a fairly uniform workforce can be maintained. This is done by amending the timing and sequence of operations that can take place partly or wholly at the same time as the critical operations.

The fourth step consists of monitoring the work, in particular the critical operations, and revising the progress chart as problems or delays arise, e.g. delayed replies from authorities, contractors or suppliers; delayed delivery of materials and subcontracted services; delays in site operations owing to prolonged bad weather.

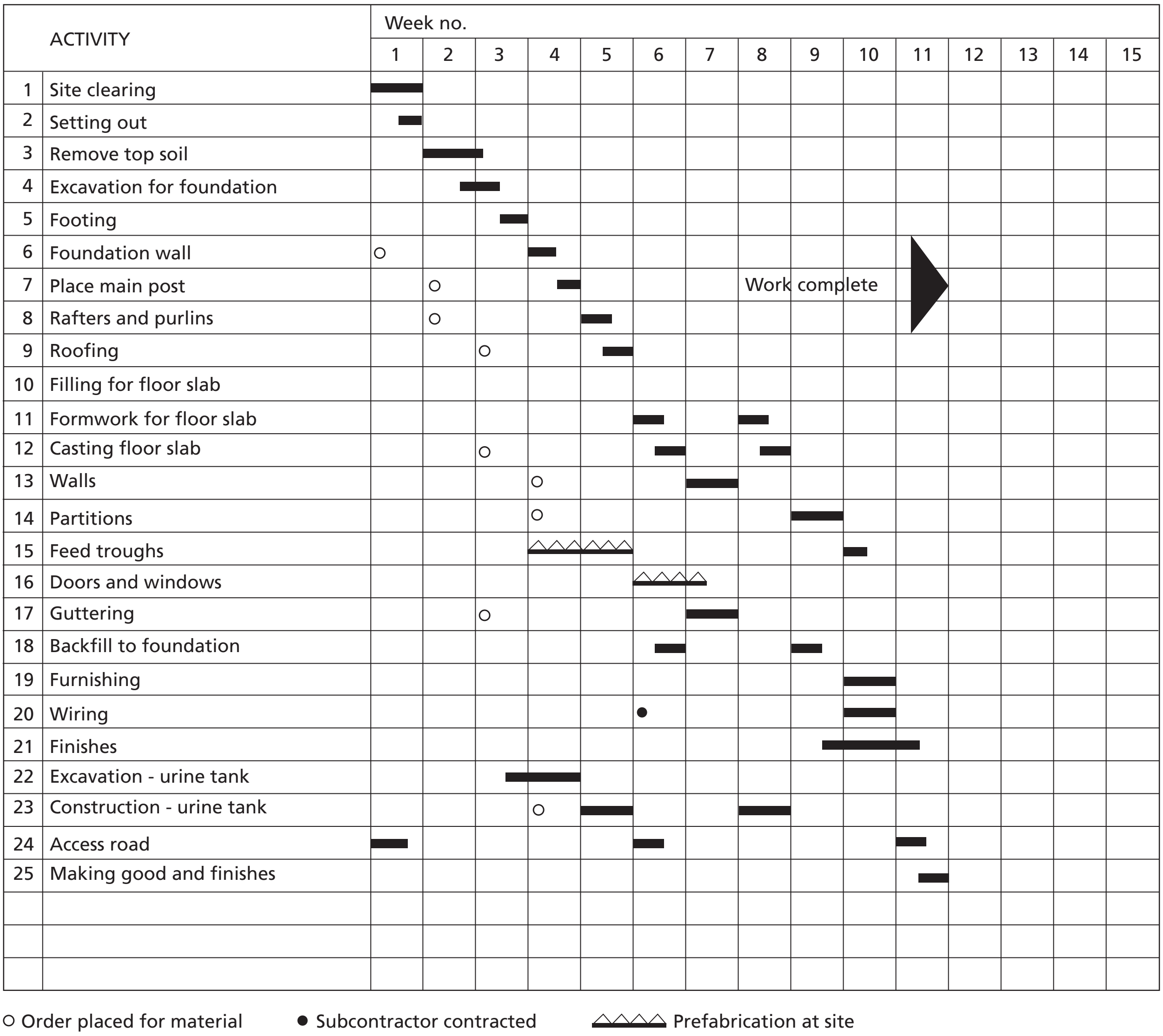

Figure 9.7 **Progress chart**

INSPECTION AND CONTROL

Whenever a building is constructed, it is likely that faults and defects will occur as a result of such factors as deficiencies in the building materials, negligence by workmen and mistakes in the drawings and specifications. Occasionally a contractor may be tempted to increase the profit by knowingly producing inferior work. To avoid this as far as possible, the employer or a person experienced in building construction (appointed by the employer) should act as an inspector during site operations. Control is normally carried out continuously as the construction work proceeds. In addition, more formal inspections are required upon completion of a contract and at the end of any guarantee period to determine whether the contracted payment should be made.

The duties of the inspector include the following:

1. To ensure that the contractor complies with the drawings, specifications and contractual provisions for the project.
2. To ensure that the project progresses according to schedule.
3. To inspect and control all materials delivered to the site and to reject any that fail to meet the specified quality.
4. To reject work that does not comply with the contractual quality and to stop work when continuation would result in substandard work.
5. On behalf of the employer, to interpret drawings, specifications and contractual provisions, and to act on the employer's behalf concerning variations.

SAFETY AT BUILDING SITES

Accidents may be caused by falling objects, falls resulting from unstable scaffolding or ladders or inadequate guard rails. Unguarded machinery, hazardous materials, carelessly maintained electrical wiring and equipment can also result in injury. Excessive haste may contribute to accidents and to wasteful, poor-quality work.

Most accidents can be avoided and safety standards improved considerably with little or no expense if the following basic safety precautions at the building site are observed:

1. Storing materials and tools in an organized fashion, with none left scattered around the building site.
2. Ensuring that tools, machinery and equipment are well maintained, with all guards covering moving parts in place.
3. Maintaining a clean and tidy building site with the removal of all waste, particularly scrap timber with protruding nails.
4. Making sure that all operators have been carefully instructed in the use of machinery and the handling of hazardous materials.
5. Insisting that all workers wear suitable clothing and protective gear, such as hard hats, hard-toe shoes and safety glasses.
6. Using properly designed, supported and braced scaffolds, ladders and platforms.
7. Establishing and enforcing rules as to where people can work while elevated members are being installed.
8. Making sure that all temporary wiring and electrical equipment is well maintained and grounded, and is properly used.
9. Having a good safety programme and making workers aware of hazards and how to avoid accidents.
10. Maintaining suitable first-aid equipment and supplies, and making sure workers know how to use them, to minimize the effects of any accidents that do happen.

BUILDING MAINTENANCE

Buildings deteriorate as a result of age, weathering and use. This necessitates maintenance and repair to ensure that the building retains its appearance and remains in a serviceable condition. Cleaning, repainting, reroofing and replacing or repairing broken parts, such as window panes and roof tiles, help to maintain the original value of the building.

Maintenance costs can be kept down by using materials that are suitable for the climatic conditions and with which local builders are accustomed to working. Furthermore, the building should be simple in detail, have easily replaceable parts and be free of unnecessarily complex or sensitive technical installations.

The fabric of a building should be thoroughly inspected once or twice a year to assess the performance of the different elements of the building. The inspection will result in a list of repair and maintenance jobs that should be carried out promptly, because insufficient or delayed measures will accelerate deterioration. Although maintenance work is usually carried out by the farmer, in the case of large repairs it may be carried out by hired building workers or a contractor. When a contractor is engaged, payment is often made on the basis of time and materials used according to an agreed schedule of prices.

REVIEW QUESTIONS

1. Define building production.
2. When does the building production process begin?
3. Briefly describe the various types of prefabrication.
4. Outline the role of a quantity surveyor in the building production process.
5. Describe the terms 'take-off' and 'bill of quantities'.
6. Briefly describe the building costing process for rural structures.
7. Differentiate between the 'physical life' and the 'economic life' of a building.
8. Briefly describe the tendering process in building production.

9. Outline the three types of tendering that are used in building construction.
10. Describe the progress chart as used in building production.
11. Explain the role of inspection and control in building production.
12. Describe some of the safety standards that should be observed on a building site.
13. Why is it necessary to maintain a building?

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