3. Stimulation and improvement or establishment of locally based materials or elements production

a) Luristan, Iran
b) Caspian, Iran

by

John Norton

April 1980

Stimulation and improvement or establishment of locally based materials or elements production.

Iran: Luristan, Caspian.

The first case study, in Luristan, deals with the setting up of the kilns in the area, and with making use of local skills and resources to meet local needs. The emphasis is on providing job opportunities to supplement the existing agricultural economic base, as well as supporting the local building industry, and is seen as an essential part of the development of the region which was suffering from seasonal migration to the towns for work. The case study points out that the success of these industries depends primarily upon the acceptance and involvement of the local community, and that it is insufficient to set up production units without ensuring the participation of the people who are to operate it in the future.

The case study in the Caspian Region looks at the existing tile production industry, which is facing increasing competition from new materials, with consequent threat to jobs in the area. In this case the approach is to reorganise the processes involved in tile production, so that the production becomes more efficient and profitable. At the same time the essentially labour intensive nature of the production units is maintained to ensure that local employment opportunities are not lost.

DEVELOPMENT WORKSHOP

The Development Workshop is a team of architects, planners and researchers from a number of countries who work collectively on the development of indigenous building and planning methods in the Third World. Projects have been undertaken in African, Middle Eastern and Asian countries. Members of the Workshop believe that appropriate solutions to human settlement problems can be developed from indigenous methods which have evolved from and remain in the hands of Third World communities. The Workshop works in the field of rural and urban human settlements. The development of small scale construction industries, technical training and local participation are integral to the Workshop's approach.

John Norton is a founder member of Development Workshop.

THE SELSELEH INTEGRATED DEVELOPMENT PROJECT (S.I.D.P.)

The S.I.D.P. was set up as an experimental project to investigate and apply a policy of rural development based upon a concept of 'endogenous' or internalised development. This aimed for the improvement of living conditions within the project area through active participation of the community and by the use of local resources. The S.I.D.P. worked on the development of Health, agriculture and education and building, as well as the infra structure and creation of new job opportunities.

An essential part of the programme was the training of 90 'Front line Workers' in the fields of health, agriculture and education. Specific training was also conducted for other activities in the area. The trainees later took on the task of assisting the villagers in meeting their basic health, education, agriculture and building needs. The S.I.D.P. was based in 400 km^2 of the Selseleh Region of Luristan, western Iran. This is a high basin ringed by the Zagros Mountains.

The Development Workshop were the Architects and Planners for the S.I.D.P. from 1975-78.

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SMALL SCALE INDUSTRIES

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STIMULATION AND IMPROVEMENT OR ESTABLISHMENT OF LOCALLY BASED MATERIALS OR ELEMENTS PRODUCTION

A SELSELEH, LURISTAN, IRAN

A.1 Introduction

As an inherent part of providing means to achieve appropriate building solutions and methods where local builders and the population in general have control over the provision of the shelter needs, it is not sufficient to simply ensure that there are people capable of meeting these needs, and that they are conversant with a range of different requirements and solutions. Trained builders and artisans (see Builders Training Workshop Case Study), must be backed up by a variety of production units providing those elements and items which are not available in a natural state locally. This covers a wide range of activities. The case study of this aspect of the work carried out by the Selseleh Integrated Development Project (S.I.D.P.) in Luristan, Iran (see S.I.D.P. introduction), is a useful example of some of the things that can be done and some of the problems that one can expect to face in their implementation.

One of the aims of the S.I.D.P. was to make as much use as possible of the locally available resources, and at the same time, create more and alternative job opportunities, thus strengthening the economic base of the region. This approach covered agriculture and handicrafts as well as items more directly related to the local building industry.

A.2 Existing supplies and resources.

At the time that the S.I.D.P. programme was set up, the use of building materials fell into two basic categories: materials immediately available in the region, used largely

in an unprocessed state; mud, timber, sand and some stone; and materials brought in from outside, most of which had been through some form of processing before arriving in the area; these included fired bricks, lime, cement, steel and some timber (particularly sawn timber.) Some of these materials had to be transported by truck for considerable distances and over extremely poor roads. The extra cost of transport was extremely high, and in the case of fired bricks which were normally brought from Malayer (see Map Fig. A.1), a distance of 200 kms, the transport cost was 100% extra on the cost of the bricks. Additionally, difficult road conditions, often in poor weather, made these deliveries unreliable. Nationally there were shortages of certain materials at various times (e.g. bricks or cement) which further hampered the possibilities of completing buildings during the dry period of the year when most building took place (May to October).

Within the Selseleh Region there were a number of natural resources, and the potential for producing more, for example by re-aforestation. The natural resources included limestone, clayey soils, sand, plentiful supplies of water and scattered deposits of chalk. These materials formed the basis for providing a range of local building materials at low cost and that could be easily used by the local population.

A.3 Planning and village organisation

The first steps to be taken in setting up new or improved production industries were to find out what materials were available and what skills also available for the various processes that these materials required, and finally to find the best sites for setting up these industries. This depended upon the exact locality of raw mat-

Fig A1

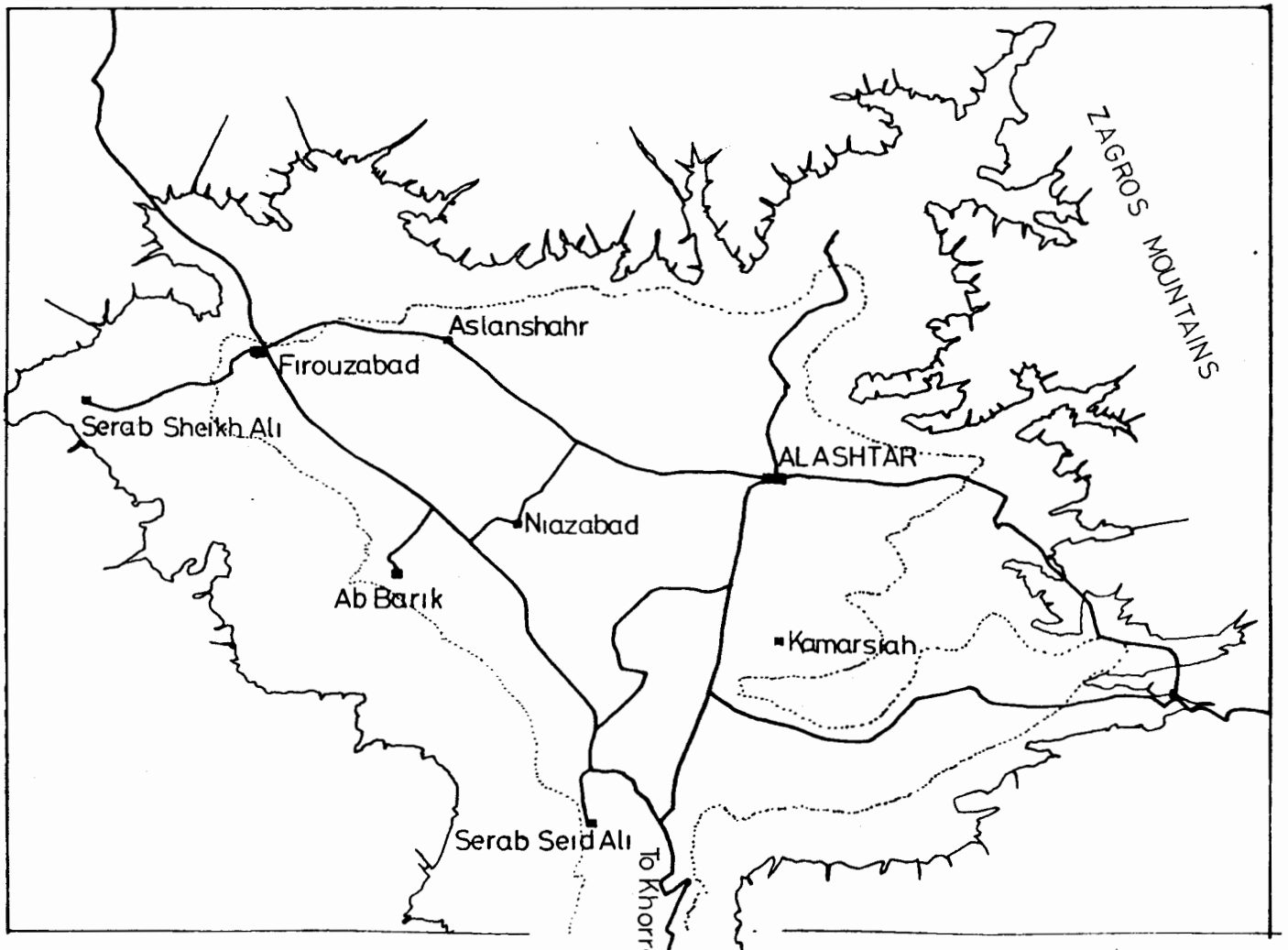


Fig A2 THE SELSELEH BASIN

erials, ease of access for collection and deliveries and the availability of people ready to participate in the new activity.

The still predominantly feudal structure of many of the villages in the area made the proper organisation of labour and management essential since the intention was to set up a system that would be devolved to the total control of the community after the initial setting up period by the S.I.D.P. This was closely linked to the other activities of the S.I.D.P. The trainee health, agriculture and education team, who were initially paid for by the S.I.D.P., would in future by paid for by the community that they served.

SERAB SHEIKH ALI

The relationship developed for the village of Serab Sheik Ali (Fig. A.2) illsutrates the broad principle.

In the village the three front line workers who had been trained by the S.I.D.P. were based in a collective building, providing a small clinic, teaching space and storage for agricultural items, such as seeds. Adjacent to this was a small experimental agricultural plot. The task of the front line workers in addition to their basic trained skills, i.e. health work, was to stimulate and assist local productive activities such as weaving, and to help in the establishment of public services in the village.

A brick kiln was also set up outside the village by the S.I.D.P. The kiln provided work for labourers in the village who owned no land and/or were working seasonally. The front line workers had organisational and financial responsibility for the kiln, whilst they were not actually in charge of its practical running. Profit from the

kiln pays for the font line workers, who are now in effect supported by the efforts of the village, and any extra profit is channelled into providing new required facilities, hence providing direct benefit to the whole community.

A.4 Kilns

After discussion with local builders in the Selseleh Region, it was decided that a selection of kilns should be set up to produce fired bricks, lime and chalk for building. One of the older builders had had some experience in operating a kiln in the past and there were remains of kilns in the area, around Alashtar.

Because the smoke from the kiln would pollute the air, locating it near to Alashtar, the regional centre (Fig.A.2) was decided against. In addition, Alashtar was also attracting more investment and therefore more job opportunities, whilst in part the aim of the small scale industries programme was to provide better opportunities in the villages.

Several sites were visited to find out their suitability for setting up a kiln and to see whether the roads leading to them could be used by small lorries. Soil samples were taken at each site and tested to see whether they were suitable for brick making. After a basic selection, second visits were made to chosen sites to discuss with the locals the availability of water and who would be interested in working at the kiln if it was set up.

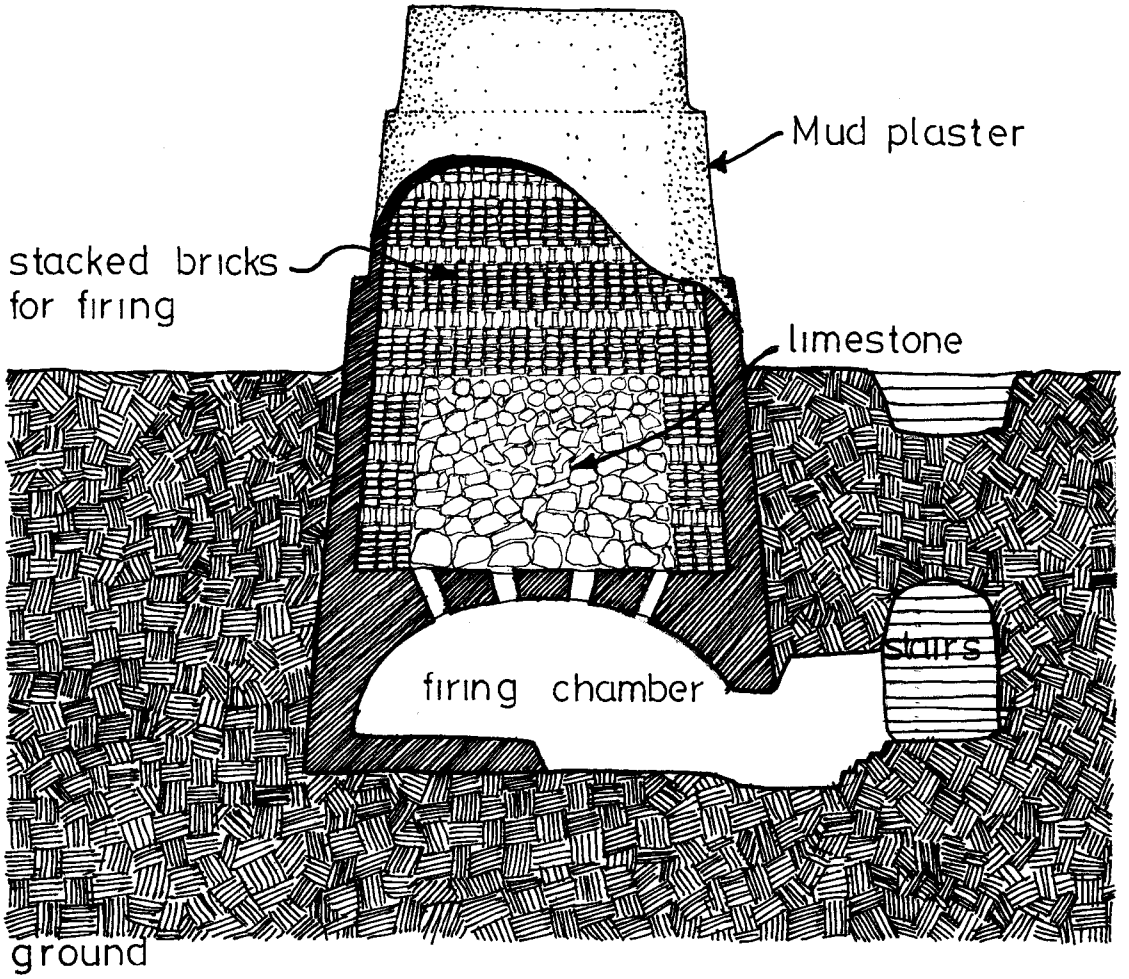
Finally, for the first kiln, the village of Kamarsiah (Fig. A.2) was chosen. Water to the kiln site was available in an open channel on a shared basis with the needs of the agricultural land nearby. This water was used to

fill a reservoir on the site. Later, because of agricultural demand, this water supply became too unreliable and it was necessary to dig a well. It would have been better to do this at the beginning.

Two updraught kilns were built, using the traditional design of the area (Fig. A.3), using oil for fuel, which was cheap (subsidised in Iran) and easy to obtain. The usual method of firing kilns in the general area is to have a small reservoir - 200 litres - from which a pipe supplies a drip feed into the firing chamber. This is difficult to regulate and inefficient. As the oil level drops, so the frequency of drips also decreases. Oil falls onto the floor of the firing chamber where it burns. In the new kilns a large fuel reservoir was built, providing enough head to introduce fuel into the firing chamber under pressure. This results in a finer distribution of fuel and more efficient combustion. The constant pressure from the reservoir makes the system easier to regulate and control.

Several problems hampered the smooth operation of these two kilns. Whilst the villagers had been enthusiastic about acquiring a source of income as an alternative or supplement to the local agricultural and animal husbandry potential, in practice they were nervous of committing themselves to the new kilns. Each time that temporary work was required, all the labour would disappear from the kiln, since they feared that they would not be employed in the fields again if they failed to turn up, and equally believed that, after the S.I.D.P. contribution and control was removed, the kiln would not support them financially, and there would be nothing else to turn to. This situation was unfortunately encouraged by one of the landlords in the village, who feared that his cheap supply

Fig A3 KILN IN KAMARSIAH



CUT AWAY SECTION

METRES

0 1 2 3 4 5

of labour was being eroded.

Because the workers on the kiln were constantly changing, it was difficult to develop a team who could operate responsibly and carefully. This resulted in poor quality and productivity: the soil on the site was suitable for fired brick production but occasionally contained small lumps of lime which had to be removed. The process for removing them was simple (by seiving and sedimentation pits) but was often not performed rigorously. Batches of bricks were produced with lime in them, and were therefore unusable. Without improvement in the quality of production, the kiln would in effect not pay for itself, and the fears of the villagers would be justified. To avoid this and to allow confidence to develop that the kiln was of value to the village, one of the kilns was switched to lime production, using limestone from adjacent hillsides. This was a very much easier process, required much less skill and the product was guaranteed to be saleable.

Problems varied between villages. The brick kiln set up at Serab Sheikh Ali was more successful than Kamarsiah, and was largely a reflection of the attitued held by the people in the village towards a scheme of this sort.

A.5 Woodworking and metalworking

Public building in the Region generated new needs and possible productive activities. Previously, the existing public baths in the area used boilers made elsewhere. With the building of new public baths the possibility developed for making boilers in Alashtar, which would save money and help the small metalworkers in the town. Based on a prototype brought from Hamadan for the first public bath, several hot water boilers were built in

Alashtar for the village public baths. All the work was done in a metal working shop run by the S.I.D.P., using local apprentices. Apart from the cheaper cost, the main advantage over the old boilers was that in future any repair and maintenance work could be done locally. This same workshop also built a number of solar collectors, developed for use heating water on the village public baths.

In Alashtar there was also a small vocational workshop equipped with carpentry machinery, but which had no practical work to do. At the same time, wooden doors and windows were brought from Khorramabad, the provincial capital. It was logical to give this work to the school, who were then able to get practical experience whilst the joinery needs in the S.I.D.P. assisted buildings were met locally. More elaborate work was undertaken as their skill increased.

A.6 Conclusion

Although the potential resources existed, it was often difficult to establish new industries where there had been no background in this type of work. It required considerable guidance and encouragement, after the initial setting up process, to develop the confidence needed for successful future operation. In this respect careful use of human resources was far more important than the use of material resources. It would have been insufficient to consider the programme purely in terms of providing the capital and basic skills needed to start up a production unit.

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b) Caspian, Iran

by

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April 1980

SMALL SCALE INDUSTRIES

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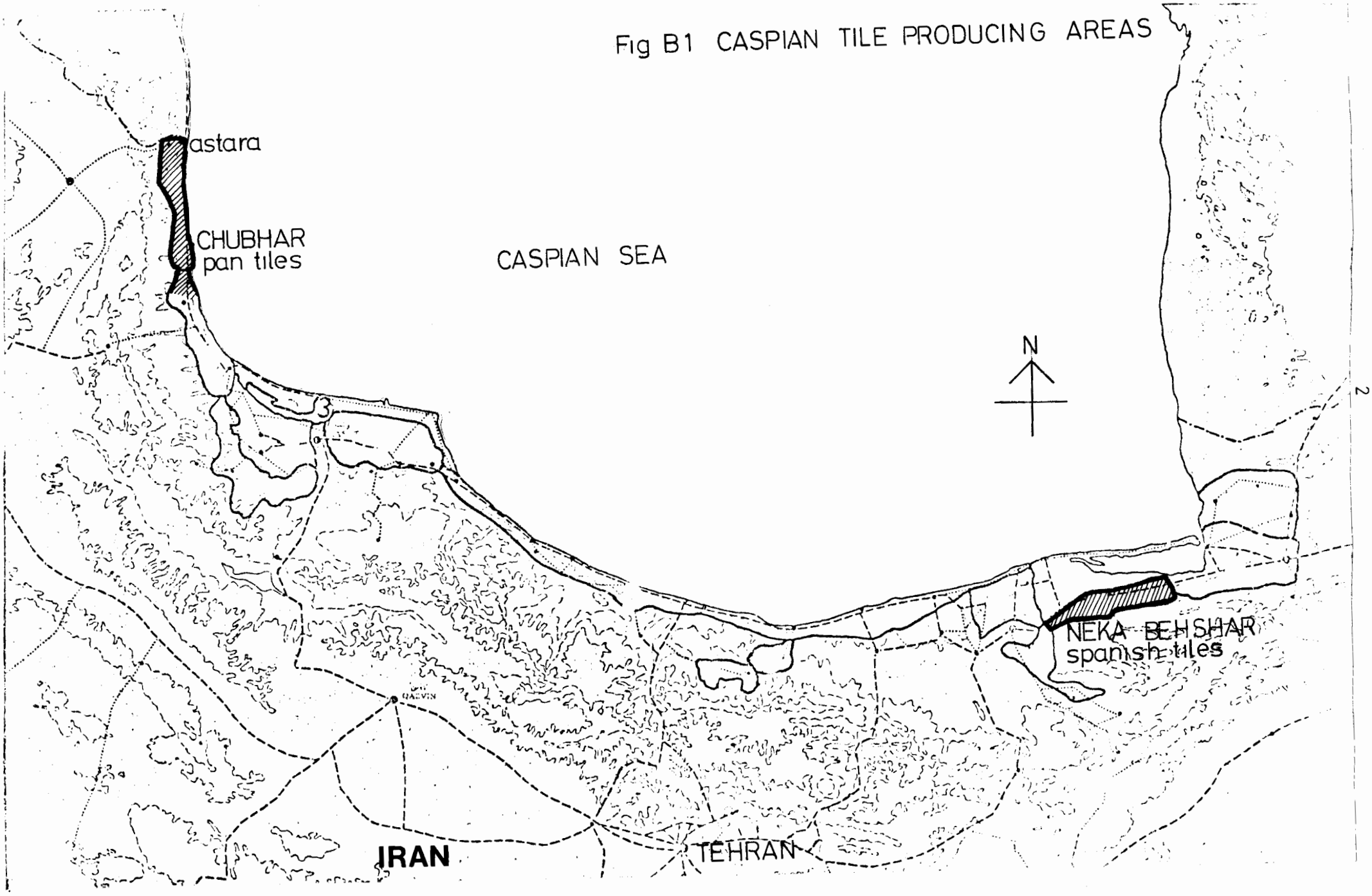
B CASPIAN

B.1 Introduction

Small scale industries in the Caspian Region of Iran (Location Fig. B.1) play an active part in the economy of the region. Small workshops and kilns are scattered throughout the area, processing timber into component parts for buildings and producing tiles for roofing. Brick kilns are less common nowadays but have been replaced by the viable activity of producing cement blocks. Nearly all these industries are catering for local demand, and are extremely susceptible to changes in the local economy and building methods. These are an important factor in understanding the condition of building material industries in the contemporary situation of the Caspian.

The traditional pattern of building in the Caspian Region makes good use of materials which are available in the immediate locality of the building. This means that there are a very wide range of different building types and materials, and material production sites have consequently catered for quite a small market area. Much of the local building was done by owner-builders and village assistance. Labour was usually paid for in kind, in terms of providing meals during the building process and helping your neighbour in turn when he required assistance. Two notable changes have occured in recent years: people have changed over to the system of paying money for labour, with an increased awareness of the amount of time involved in building resulting from this, and two materials which are widely regarded as being long lasting and relatively maintenance free, concrete block and galvanized sheet metal imported from outside the region, have been introduced into the area, and are generating a more unified style of building throughout the region. Of all the production sites that are flourishing, small yards employing 2 or 3

Fig B1 CASPIAN TILE PRODUCING AREAS



men to produce concrete blocks are the most common and successful. The more traditional materials, such as tiles for roofing, are often being spurned for the attractiveness of the new materials which are often somewhat erroneously believed to be longer lasting and maintenance free.

During the summer and autumn of 1978 Development Workshop conducted an extensive survey to ascertain what the condition of the rural building industry was in the area, what problems it faced and what could be done about it. The results of this survey, produced certain conclusions:*1 amongst which certain of them relate directly to the choice of building material and the methods by which those materials are produced and used.

B.2 Roofing - Change and Effect

The cost of roofing with galvanised sheet metal was, in 1978, an average of 10% more than the cost of roofing a similar space with 'Spanish' or 'Pan' tiles in the areas within which these latter materials are produced. *2
The life span of the sheet metal was no greater than the tiles, and the maintenance requirements were in come cases more. The 'Pan' tiles produced in the Astara region required practically no maintenance. Furthermore, people living in houses roofed with sheet metal, whilst admitting that the material had a prestige value, pointed out that their roofs were poor insulators, transferring extremes of temperature to the interior rendering them unsuitable

*1 Produced in full in: DARAIE. M.R; CAIN. A; NORTON. J; AFSHAR. F; INDIGENOUS BUILDING OF THE CASPIAN REGION Tehran, Iranian Institute for Peasant & Rural Studies 1979. Limited Edition. 457 pages. Text, illustrations.

*2 See Appendix 1 for comparative costs of roofing materials in Caspian Region.

for food storage, a popular practice in the houses with tile or thatch roofs found in the area. They also complained that the metal roofs were poor accoustically and that during rain storms the noise on the roof was considerable. Weighed against this were the attractions of prestige and the relative simplicity of putting up the sheet metal roof.

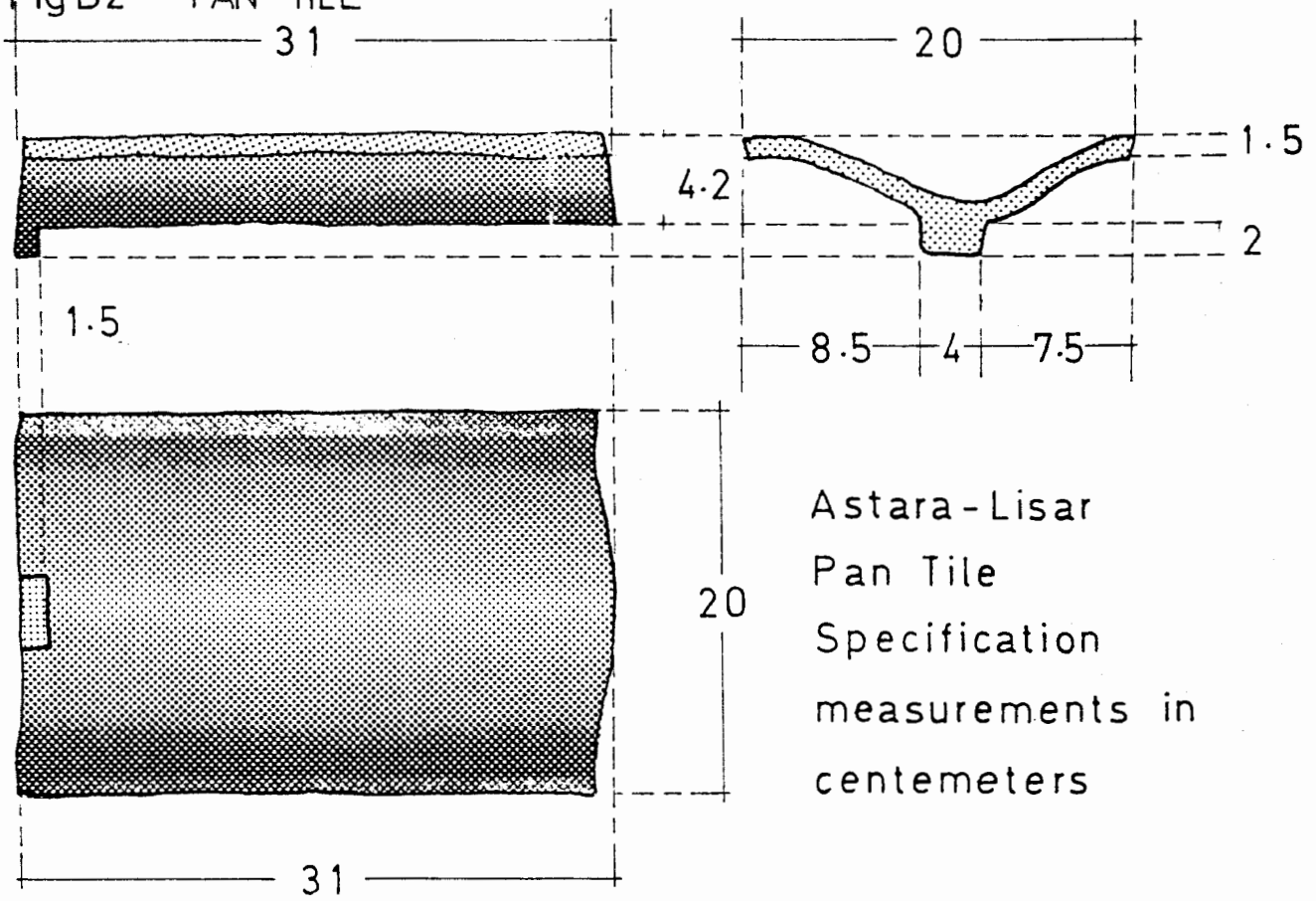
The conclusion drawn from this was that, albeit there are advantages in using tiles or thatch, the sheet metal roofs are gaining in popularity and use.

This has had the effect that tile kilns which previously operated at a small profit, in losing custom, have ceased to be economical and have gone out of business in all areas except for the kilns around Astara. In consequence, job opportunities have been lost, forcing people to migrate to other areas, local resources are not being used, and valuable capital is being spent outside the region, instead of stimulating and circulating within the local economy.

Of the different tile producing areas, it was concluded that for the Neka/Behshar area the market still existed for tiles, if they could be produced at lower cost, and that in the Astara area the tile industry, whilst still being active, could greatly improve in terms of efficiency, and by lowering the costs, could cater for a wider market area. In both cases the existing processes were not making full use of their potential.

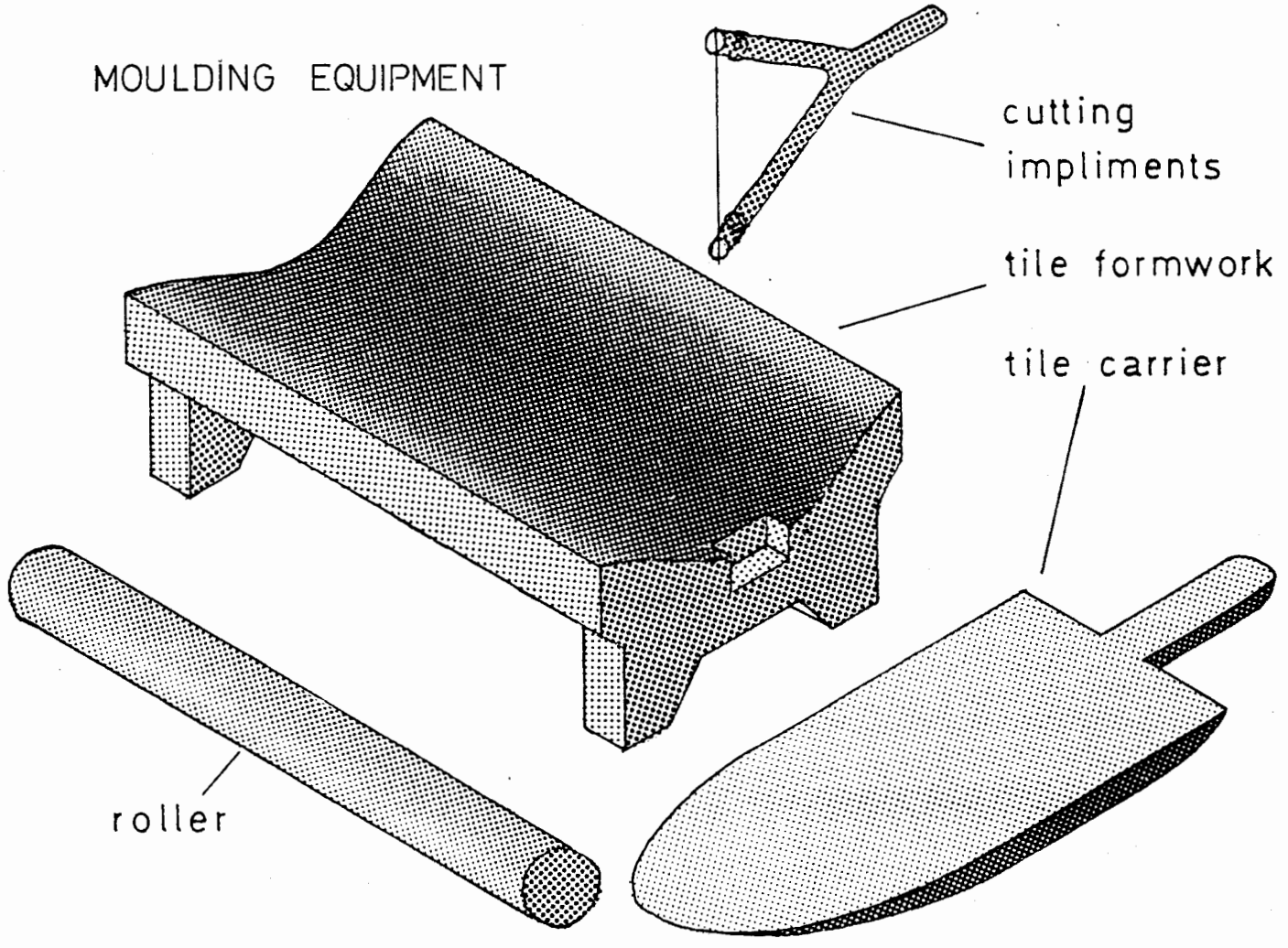
B.3 'Pan' Tile production. Chubhar, Gilan (Astara Area).
The tile kilns in the Astara area produce a 'Pan' type tile, measuring 31 x 20 cms, with a shallow 'S' shaped profile. (Fig. B.2) They provide a good coverage on

Fig B2 PAN TILE



Astara-Lisar
Pan Tile
Specification
measurements in
centemeters

MOULDING EQUIPMENT



the roof with a minimum amount of overlap between tiles. Because this is a single lap tile, its weight is relatively less than the double lap tiles used in the Neka/Behshar area, and the roof structure required to hold it up is less.

The existing process of making tiles in the Astara area is highly labour intensive process. The kiln described in this case study at Chubhar, employed 5 people. One man ran a horse driven clay mixing mill, where clay, after soaking in water, is mixed until it has the right consistency for moulding into tiles. Clay comes from nearby. (Fig. B.3) This mixed clay is delivered to the moulding and drying sheds. These sheds are low covered structures which provide shelter from direct sunshine and rain, but which allow air movement through the shed which is important in the drying process of the formed tiles. In the centre of the drying shed is a space set aside for the moulding of the tiles. An assistant takes the clay which has been brought from the mill and forms it into lumps, each lump sufficient for one tile, and then rolls it flat. The tilemaker cleans his shallow wooden mould and sprinkles sand over it to prevent sticking. The clay is pressed into the mould with a wooden roller, and extra clay is trimmed off round the edges. The mould and clay are turned over onto a suitably shaped platter, which the assistant uses to carry the tile to the drying racks. The drying sheds surveyed could hold more than 9,000 tiles. Drying takes 2 to 3 weeks. When the tiles have dried to about 10% moisture content and are rigid they are ready for firing. Loading the kiln takes one day, firing another four, and a final day for unloading. About 700 tiles are produced by a team each day. About 7,500 tiles can be fired in a week, In this kiln there were two teams of men moulding tiles.

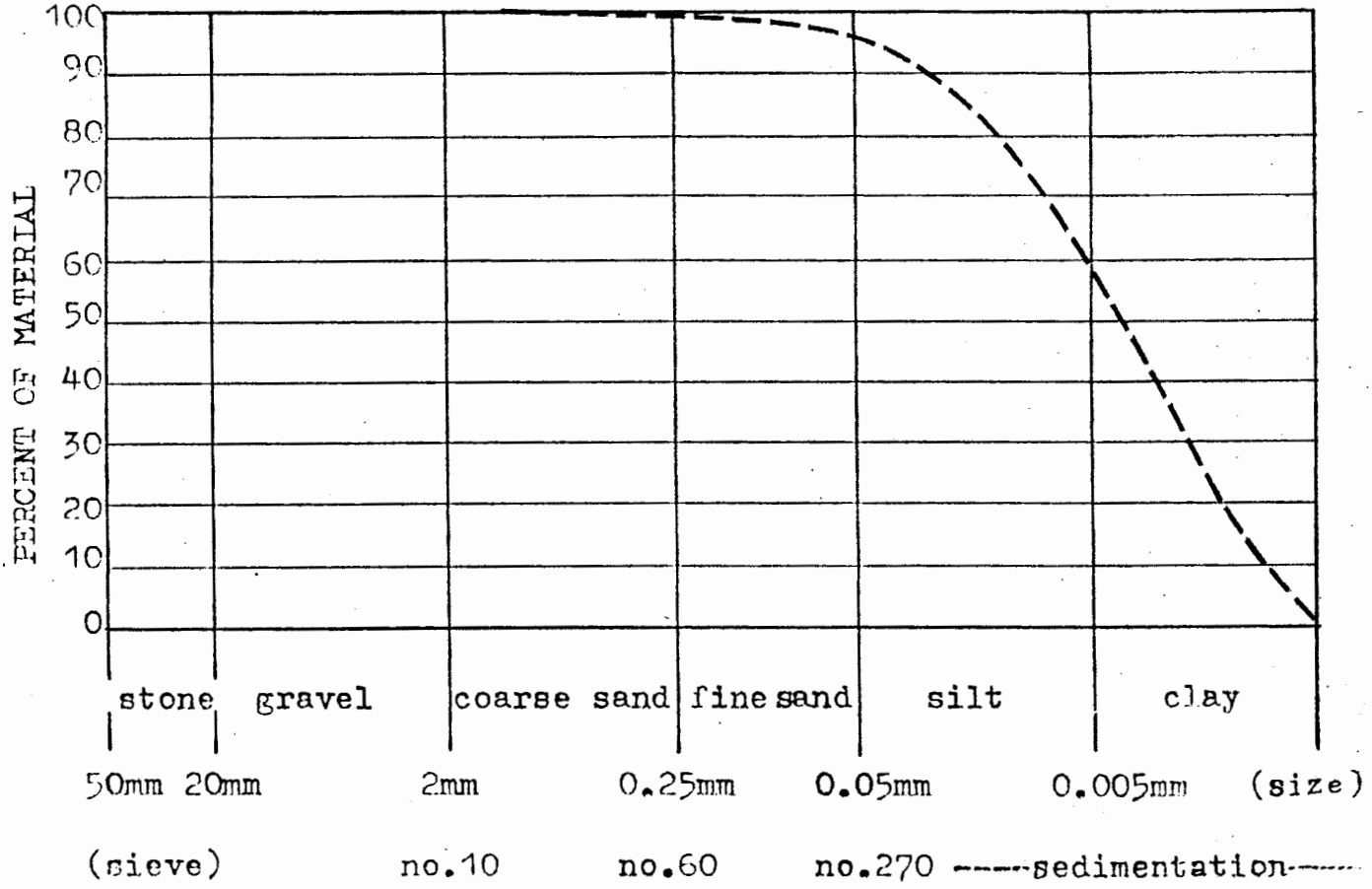
Fig B3 MECHANICAL ANALYSIS OF SOIL

LOCATION: Chub-bar , Gilan, Iran

SITE: tile-kiln

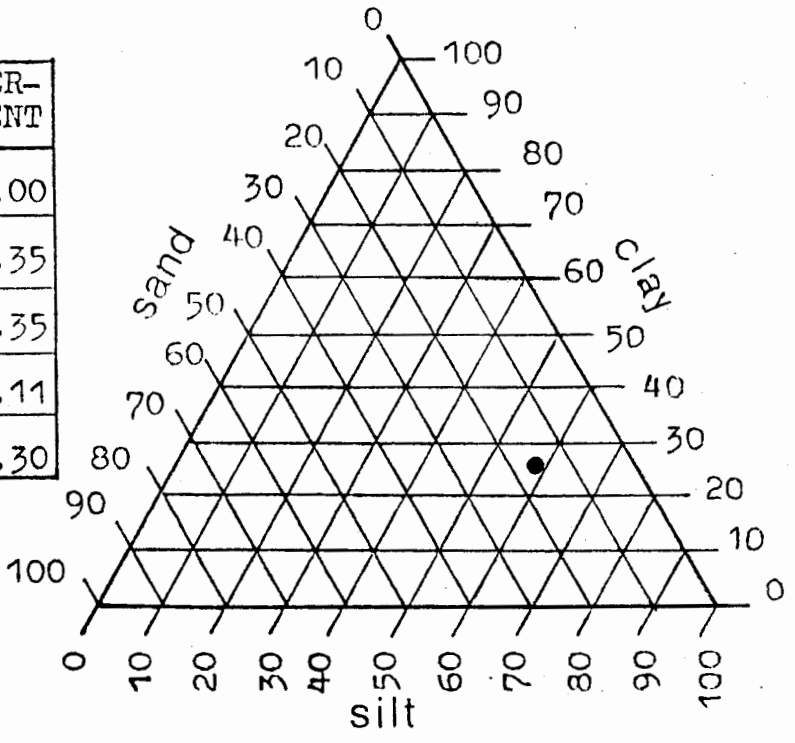
DATE:

Granulometric Chart



Particle Gradation

PARTICLE	mm SIZE	no. SIEVE	PER-CENT
Gravel	+2	10	0.00
Coarse Sand	+.25	60	0.35
Fine Sand	+.05	270	14.35
Silt	-.05	270	59.11
Clay	.005	sed.	26.30



Classification Chart

Soil Classification:

Clay-Silt

Tile moulding is contracted at a rate of 4,000 Rials (Iran) (approx. US$ 60 at 1978 rate) per thousand to the master who is responsible for the skilled work of actually moulding the tile. He in turn pays a daily salary of 500 Rials (approx. US$ 7 in 1978) to the worker operating the clay mill and 600 Rials (US$ 8.5 in 1978) to his moulding assistant.

The kiln is fired with wood and costs about 5,000 Rials per firing (US$ 70 in 1978). (Fig. B.4) At the time of the survey tiles were marketed at a cost of 9,000 Rials (US$ 130 in 1978) per 1,000 tiles. Rapidly increasing labour costs have raised tile prices in the previous 3 years from 3,000 Rials per 1,000 (US$ 40) but the tile is still competitive with other roofing materials and is favoured in the area.

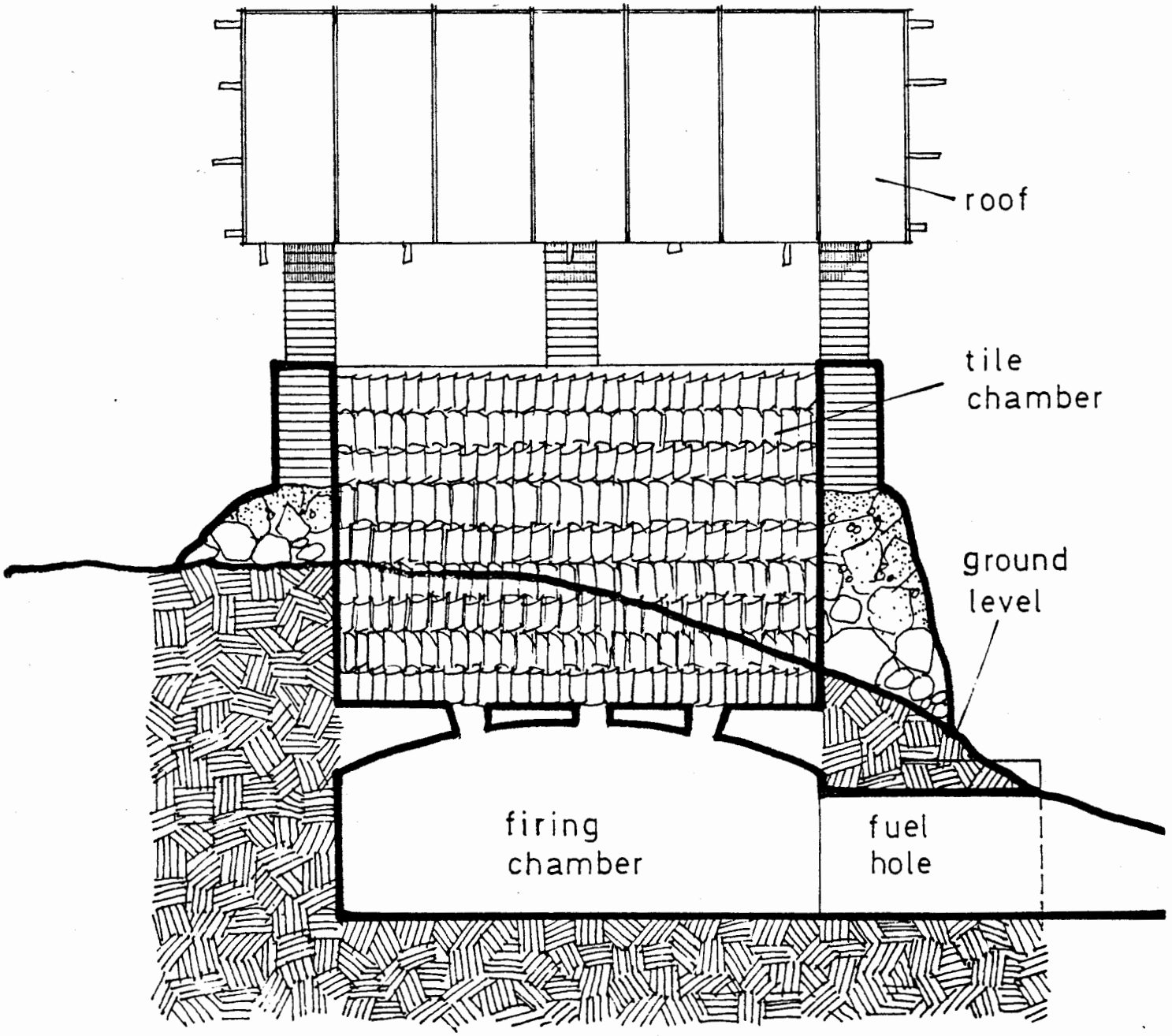
Tiles are only produced over a 6 month period (Summer). In winter the atmosphere is too damp and tiles will not dry enough to be ready for firing.

B.4 Improvements

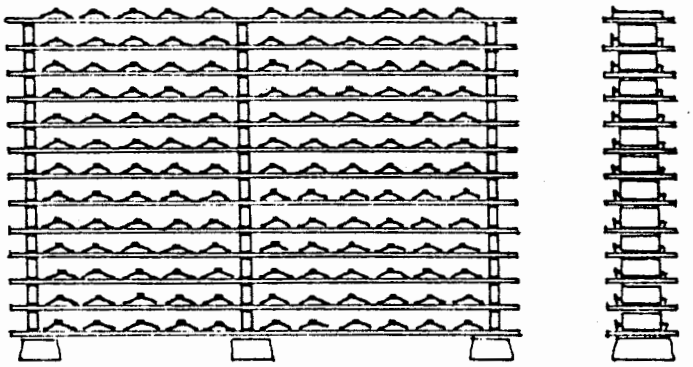
It was possible to propose various improvements to the production in the area. However, it was essential that, whilst efficiency needed to be improved if the tiles were to remain competitively priced, any alteration to the present system had to be at minimum cost and without removing employment generating component in the industry. The kilns in the area were all labour intensive and labour was a significant item in the running costs of the kilns.

The capital costs involved in introducing mechanisation into the process were regarded to be too high for the small production yards in the Caspian, although mechanical moulding and mixing would have greatly increased the output.

Fig B4 Tile Kiln - section
Chubhar , Gilan



Tile Drying Racks



There would also be a degree of centralisation into larger production units, which would in the long run cease to be an important source of rural employment.

Rationalization of the tile making process was regarded as being the best approach, without destroying the employment generating potential.

It can be seen from the plan of the Chubhar kiln (Fig. B.5) that the positioning of elements; work areas, drying racks, and kiln; are in a random fashion. A great deal of time and labour is spent transporting clay to the work area, and the tile to the drying racks and then to the kiln. Additionally, because the firing process requires several days for unloading and cooling, tiles cannot be fired continuously. Also, because of the intermittant nature of the firing process, requiring periodic labour inputs, there is little specialisation of the production activities. (Fig B.6) It was proposed that the production method could be rationalized by improved site organisation and better management of labour.

Fig. B.7 shows the proposed layout for an upgraded tile production site in the Chubhar area. Two kilns, fired alternatively, are used, so that tiles are being constantly burned. Elements such as the clay mill and drying racks are positioned so as to cut down transportation distances. The same production method as already exists in retained, being directly related to employment. However, a high degree of specialization means that the tile-moulder or his assistant need not leave their work periodically to help load or unload the kiln. A new specialised role of kiln keeper is created; he has the skilled task of supervising the laying of the kiln and maintaining the firing temperatures. He has an assistant

Fig B5
Tile Production Unit
Chubhar , Gilan

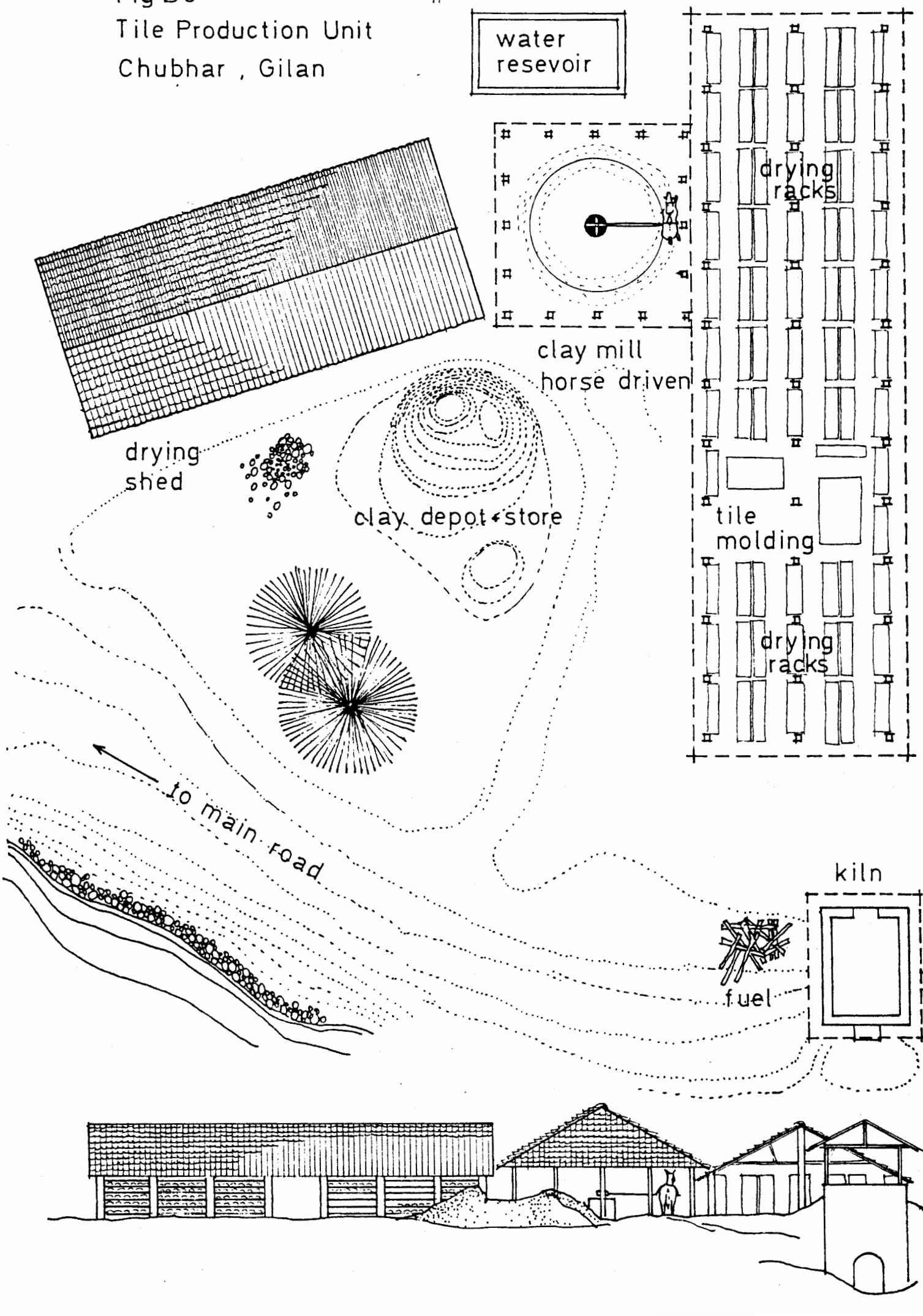


Fig B 6

Traditional Tile Production System

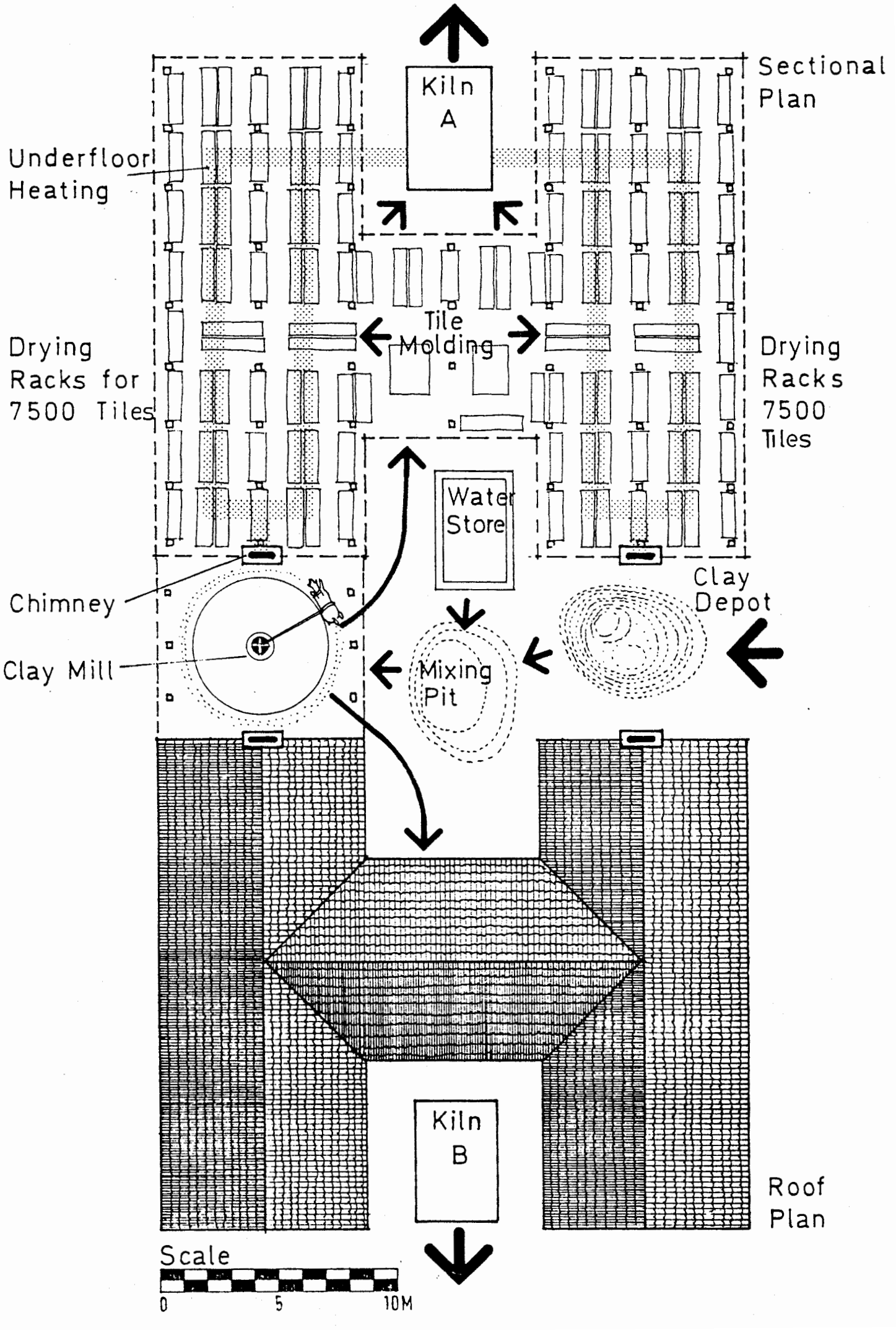
From the Chubar Kiln

(Output 7,500 tiles per week)

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Wage in Rls.
Kiln Schedule	l	f	·····	·····	····· ➤	c	u	l	f	·····	·····	····· ➤	c	u	
Tile Maker 1	l	f	Moulding				m	l	f	Moulding				m	1500
Assistant 1	l	f	Stacking				u	l	f	Stacking				u	600
Tile Maker 2	Moulding ····· ➤							····· ➤						·····	1500
Assistant 2	Measuring and Stacking ····· ➤							····· ➤						·····	600
Mill Worker	Milling ····· ➤						u	Milling ····· ➤						u	500
													Total Labour Cost		4700

l	Loading Kiln	u	Unloading Kiln
f	Firing Kiln	m	Moulding Tile
c	Cooling	▒	Holiday

Fig B 7 IMPROVED PRODUCTION SYSTEM



who also helps work on the mill on the days that there is no work in the kiln. (Fig. B.8) With the present firing and production methods, this alteration results in an increased efficiency of about 27%.

It was also suggested that the exhaust heat from the kilns could be used for pre heating and drying tiles before being put in the kiln. About 30 - 40% of the heat generated in the kiln and the kiln structure is lost to the atmosphere in cooling after the firing period. By channelling this exhaust and waste heat under the drying area, the drying process could be improved.

The major effect of this would be to increase the period of tile production from the present 6 months to nearer twelve, hence doubling production. It still remains to be seen whether the market demand in the area will justify this extra production.

Alternative fuels to timber are also available, but oil, to which the kilns can be easily converted, is rising in price in Iran as elsewhere, even though its use is subsidised. An immediate improvement to the present system was suggested: Normally, the timber used in the kiln is left out in the open before use, and still has a high moisture content, of 25% or more, being freshly cut. It was suggested that a covered storage area should be introduced, which would allow the timber to dry. Air dried oak, has a moisture content of 12-15%, as opposed to the 25% content in timber used now. Drier wood produces more heat per cubic metre, with corresponding reductions in the quantity of wood being burnt.

Improved Tile Production Unit

Fig B 8

Labour Organization and Kiln Firing Schedule

(Output 15,000 tiles per week)

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Daily wage in rials
Kiln A	l	f	.....	.....	➤	c	u	l	f	.....	.....	➤	c	u	
Kiln B	..... ➤	c	u	l	f	.....	..... ➤		c	u	l	f	.....	.....	
Kiln Keeper	A	A	B	B	B		A	A	A	B	B	B		A	1000
Kiln Worker	A	M	B	B	M		A	A	M	B	B	M		A	500
Mill Worker	Operate Clay Mill ..... ➤													.....	500
Tile Maker 1	Moulding Tile for Kiln A ..... ➤													.....	1500
Assistant 1	Measuring Clay and Stacking ..... ➤													.....	600
Tile Maker 2	Moulding Tile for Kiln B ..... ➤													.....	1500
Assistant 2	Measuring Clay and Stacking ..... ➤													.....	600
Apprentice	Moulding Tile Alternately for Kiln A&B													.....	800
													Total Labour Cost		7000

l Loading Kiln

f Firing Kiln

c Cooling

u Unloading Kiln

A Kiln A

B Kiln B

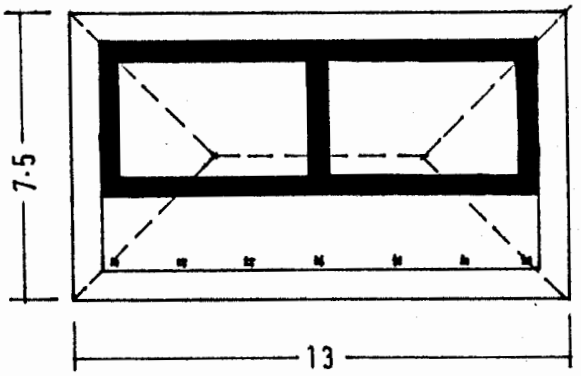
M Mixing

▒ Holiday

B.5 Conclusions

In this case, the improvements were all within the capability of the existing skills and resources. Nothing new was required from outside the area. Improvements are necessary if industries which are viable now are to remain so in the future, as they face increasing competition from new materials and techniques brought from elsewhere. Another kiln, in the Neka-Behshahr area (Mazandaran) had ceased to function because, whilst there was still a demand for tiles, they could no longer be produced at efficient costs. A more substantial reappraisal of the production method and tile form was required. Changes to the tile form in the Neka/Behshahr area (Spanish tiles) would, however, require major alterations to structures, since a tile which produced a more efficient coverage for the material used (i.e. a 'Pan' tile as used in the Astara area) would need a different arrangement of battens on the roof. The acceptability of such a change needed to be established before implementation of changes to production could take place.

*2 The unit of construction is taken to be a standard two room house with a front 'aivan' covering a built area of 97.4m. The pitch of the roof varies according to the different roof covering material used and thus the surface area of the roof to be covered also varies.



On comparing Costs:
The costs should be regarded in connection with the lifespan of the material, although in rebuilding the roof after its period of lifespan some materials may be salvaged in certain cases and the cost of the new roof is not necessarily as high as the original roof. Also it should be noted that low income groups find it economically easier to invest a small capital in a relatively short term structure than a large sum in a longer lasting building. Thus a relatively small initial capital outlay with periodic inputs for maintenance is more geared to a rural family's economy.

ROOFING MATERIALS: COMPARATIVE COSTS

name of material	Rice Thatch	Reed Thatch	Shingles	Rasht Tiles	Astara Tiles	Sheet Metal
local name	Koloush	Lee	Lat/ Takhteh	Sofal	Sofal	Halab
cost*1 of material/m^2 Roof Surface Area	0.075	0.155	0.333	0.378	0.450	0.413
cost*1 of construction/m^2 Roof Surface Area	0.133	0.133	0.050	0.165	0.050	0.166
total cost*1/ m^2 Roof Surface Area	0.208	0.288	0.383	0.543	0.500	0.579
pitch of roof°	55°	55°	25°	25°	35°	25°
surface area of roof m^2	170	170	110	110	120	110
cost*1 of material/unit of construction	12.5	26.	37.5	41.	54.	45.5
construction cost of unit*2	22.5	22.5	5.5	16.5	6.	18.5
total cost of unit *2	35.	48.5	43.	57.5	60.	64.
lifespan yrs.	8-12	15	15-20	25-30	25	20-25
maintenance requirements	thatch renewed in parts of roof. Ridge rope tightened & replaced when rotted.	ridge rope tightened every yr. & renewed when rotted.	shingles turned over every 5 years.	lower tiles moved to the surface after 15	-	joints loosened by wind are tightened. Rusted holes are fixed