

1983 TECHNICAL REVIEW SUMMARY

The Chikal Village Literacy Centre
Chikal , Niger

398.
NGR.

As part of an inter-disciplinary and integrated approach for the development of a typical Sahelien village , the Literacy Centre was built to meet community needs while offering an opportunity to introduce new design elements and test the appropriate technology .

Date of Completion : December 1980

Introduction

Chikal Literacy Centre should not be seen as an individual building but should be considered in the large context of " Project Tapis Vert "'s anti-desertification programme . (1)

The long range goal of Project Tapis Vert (PTV) is to improve the quality of life of the villagers in the areas stricken by desertification and the consequent low agricultural productivity .

PTV in Chikal area has been created as a prototype for the development of a typical Sahelien village , the approach is inter-disciplinary (2) in research and integrated in action , the concept of socio-ecology is used .

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- (1) Previously under the direction of the Nigerian National Institutes of Agricultural Research : INRAN (Phase I and II) and presently under the direction of Ministry of Plan (Phase III) , Project Tapis Vert is a collaborative effort of two non-profit , voluntary organisations :

Strategies for Responsible Development , University of Dayton , Ohio 45469 , U.S.A.

Institute for Study and Application of Integrated Development (ISAID), Toronto , Ontario M4J2E3 , Canada (see also Annex V.)

- (2) PTV is conducting activities in the areas of watershed management and erosion control : water resource development , agriculture , gardening , forestry , animal traction and animal husbandry , nutrition , appropriate building technology , energy sources , socio-economic studies , and literacy training.

(see map 1 Annex XIV. : Location of PTV project activities .)

I. Objectives

To assist in alleviating hunger and malnutrition on a long term basis , "PTV" has the following objectives :

To institute simple , repetitive , inexpensive and appropriate means to increase food production ;

to develop techniques and methods of sustaining programmes of long-term action at the village level .

The construction research and activities that are part of this project are intended to demonstrate or assess new technologies that are appropriate , and are a response to the necessity of finding alternatives for the use of wood (1) in construction .

The objectives of this sector as for the project , in general , are ambitious :

To investigate solutions to reduce or eliminate the use of wood in village buildings (housing , storage , other facilities) ;

to investigate methods of making traditional buildings more resistant to the elements ;

to provide training and technical assistance to local masons and villagers who are interested in proven building techniques .

II. Description

History (2)

Following the disastrous Sahelian drought , and after an 18-month period of feasibility studies and negotiations , agreement was reached with the Government of Niger in March 1977 for the establishment of a long-term effort named Project Tapis Vert . The project is aimed at addressing the causes of desertification and the resulting low agricultural productivity in an integrated , sustainable manner at the village level .

Chikal , typical of the drought stricken regions of West Africa , was designated for the first PTV pilot project .

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- (1) Local timber cut for traditional roofing is one of the factors (5 to 7%) adding to the depletion of vegetation and consequent advance of the Sahara .
 - (2) See also Annex VI., VII.

The project is being implemented in three phases (1) :

Phase I (1976-1977) was an intensive study of the geology, soil , vegetation , etc. of the Chikal region . The study provided the basis for more specific project plans to meet the needs and expand the potentials of the region .

Phase II (1978-1982) was a period of applied research and demonstration .

Phase III (1982-1984) the current phase is a period of expansion , in which both the villagers and the services of the Niger government will be assisted in adopting methods found successful while applied agricultural research continues .

During the third phase , personnel will be changed and financial support from sources outside Niger withdrawn gradually , to give the people of Niger the opportunity and responsibility to carry out the project themselves .

The construction activities began in Phase II . Study and research (2) in 1979 led to the recommendation that the PTV experiment , by the use of mud brick vault and dome technology , not require the use of timber for roofing.

In 1980 , PTV sponsored an intensive training workshop in Chikal for interested local masons.

To direct the technical aspects , "ISAID" retained the services of "Development Workshop" (3) which has experience in self-help housing projects in developing countries .

The first part of the workshop involved building a small(4) practice structure to incorporate both the dome and the vault .

In the second part of the workshop , the team used the same method to put up a full size building , which comprised two large domes , for teaching "HAUSA" literacy . The masons were initially skeptical of the building's strength and the applicability of the method in Chikal . However , they readily learned the technique , with encouraging results .

The Literacy Centre building made a great impact on the village . The leading mason in Chikal was impressed and acquired both skills and a structural understanding . The project had other repercussions on village life and

(1) Annexes VIII and IX.

(2) See detailed study in Annex II.

(3) Annex IV.

(4) The building now serves as a storage shed and generator room.

resources ; a further three buildings (1) have since been erected .

The Site

The project site , which was chosen in consultation with the Government of Niger , is located (2) on the eastern side of the Dallot Bosso , 18 kilometers from the town of Filingue , in the area encompassing the five Chikal villages with a total population (3) of 6,289 in 1982 . The main activity in the area is agriculture (4) .

The area is typical of the drought-stricken regions of West Africa ; severely affected by overgrazing , deforestation , low rainfall (5) , and soil erosion .

Traditional methods of farming , herding , building , and cooking are often ill-suited to the present situation and have compounded the climatic problem in the area .

The Literacy Centre is located in Chinyassou Village (6) . The land which was held in a traditional form of communal tender was donated for the Centre .

Local Architecture

The architectural expression is simple and marked by life-style as well as possibilities . "Banco" mud construction resurfaced annually and timber for roofing are generally used to build houses , mosques, storage and other facilities .

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- (1) Meteorological station in Chikal, 1981 : The building was patterned after the Literacy Centre. It is a combination of an office and house used as the station . United Nations' Meteorological Division provided funds for materials and labour.
Allason of Illela's House, 1981 : Allason , one of the more capable masons in the workshop , chose the dome and vault method for his own house , and together with PTV staff , worked out a design to fit his needs .
Ahmadou of Itchigin's House, 1981 : Ahmadou, a mason living in Itchigin (20 km from Chikal) , joined the team to build Allason's house . Impressed by the techniques , he decided to build his own house with them .
- (2) See Annex XV. maps 1 and 2 , also Annexes XI. and XII.
- (3) Soloa 497 , Illela 793 , Lokoko 1.059, Dourgouna 895 , Chinyassou 3.075.
- (4) Mainly millet and cowpeas with little diversification . Animal husbandry takes the second place .
- (5) Precipitation : 300 to 350 mm/year . See also Annex III , Climate Analysis .
- (6) See Annex XV., Maps 2 and 3 .

Although wood and organic materials are used wisely , the amounts needed for these buildings can be appalling : A typical local mud-roofed house (1) could require as many as 48 trees and 4,275 branches . In addition , trees are used for scaffolding for construction work . Because of termite and water damage , roofs made in this manner have a limited life span (3 to 6 years) . Termite damage also results in the continual presence of dust and mud particles .

III. Design , Construction , and Use

Design Concept

The Literacy Centre was conceived (2) to meet the needs both for the PTV program of developing vernacular language (HAUSA) skills , and to consolidate the builder-trainees' skills in improved roofing methods .

The building consist of two inter-communicating spaces , flexible to house small or large group teaching activities. Both spaces are square in plan and are covered with a 3.5 m. span dome . The western end of the building contains the entrance foyer and a wind-catcher .

Climatic data gathered by PTV determined the orientatin of the building . Because the prevailing winds come from the south southwest during the hot dry season , the Literacy Centre was built with the wind catch ; major windows face south , and the dome vent faces north .

The original design for openings (windows, doors) together with the wind-catcher and the small outlet (3) in

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- (1) A number of different types of buildings were observed by PTV in surrounding area . A typical house (9 meters by 6 meters) which was surveyed during its construction , used beams every 35 cm , each consisting of a tree trunk (10-15 cm in diameter and 2.5 to 3.5 meters long) . The gaps between these beams are filled by small branches (3 to 4 cm in diameter and 40 cm long) .
 - (2) See Annex II.
 - (3) A ceramic vase on its side acts as an exhaust and is driven by the prevailing winds . But at the same time , it would allow rain and dust penetration . A new system has been studied based on recent experimentation by the PTV group on-site ; it consists of two inverted and incorporated ceramic vase-like forms , of which one contains openings to allow air circulation, and the other , which is slightly larger and set on top , protects these openings from rain and dust . The small outlet in eastern dome of Literacy Centre would be replaced in future by the new outlet system .

the eastern dome , would normally allow the free circulation of air and temper the direct sunlight as it enters .

The wind-catcher pulls air inward ; air is drawn downward and passed over two large , water-filled ceramic jars and is cooled by evaporation . Hot air is drawn upwards in the eastern dome and exhausted through the small outlet .

RAIN Although the original design incorporated a filtering system (1) to prevent dust from entering through the wind-catcher , the opening system in general was impractical as the dust AND still came through the building during the ~~rain~~ CRITICAL SEASON

Modifications

A number of modifications , for practical as well as social reasons , were later made to the Literacy Centre and to its surroundings :

The addition of a courtyard perimeter enclosure to the north of the building with a pit latrine in the northeast corner and a number of "Chulna" type experimental cooking stoves along the west wall of this courtyard . The courtyard in late afternoon is also used as an open classroom .

As entrance to the building is now only made through the courtyard , the south entrance to the Literacy Centre became redundant and was therefore closed .

The original brick lattice screening in the window opening has been replaced by louvred metal shutters which are of the most commonly available commercial variety .

The wind-catch opening was also closed . The base of the wind-catch shaft is now used for storage .

The small outlet in the eastern dome is blocked during rain .

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- (1) Finally the system was not incorporated in the building . In its future technical training on-site , Development Workshop plans to complete the windcatcher with the evaporation cooler and dust filter . They feel that this technology has a potential use in the Chikal climate .

Structure , Materials , and Technology

The structure employs load bearing walls , and vault and dome roofing .

The principal building material is clay , and some innovations were introduced in mud-brick production :

The bricks were made stronger by a 40% sand additive ; modular forms ; and a more efficient management system for production , transportation (by animal traction) , and stockage of mud blocks .

Facade renders were made more water-resistant by the addition of crushed acacia seed pods with clay .

All components were fabricated either on-site or in the village . Door and window hinge hardware was designed to be made by the village blacksmith .

Research and Training

An intensive training workshop for ten local builders and building assistants was carried out to upgrade general building skills through sharing knowledge and experience . The training focused on the introduction of methods for building vault and dome roofs without centering or formwork. A small room and a shade shelter were built and rebuilt to demonstrate the different forms and techniques .

For the Literacy Centre , the work was divided into phases : foundation , walls , roofing , and finishing ; each taking roughly a similar period of time .

Construction was organized so that each builder/trainee had practical experience with every aspect of construction .

After the completion of this project , the PTV permanent construction research group experimented with a variety of techniques on new buildings to improve local materials , and where possible , reduce costs . In the future on-site training workshop , which will be directed by Development Workshop , the recent experience will be considered and discussed for future building policies .

Origins

Technology : Vault and dome roofing without shuttering , Nubian and Iranian systems .

Material : Locally produced mud blocks , clay , Acacia pods in a stabilizing plaster , local laterite rock in soil cement .

Labor Force: 100% local of which 40% were skilled and 60% unskilled .

Professionals : Development Workshop : group 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 (Africa, Middle East and Asia) .

Project Tapis Vert integrated team of professionals in the fields of ecology , sociology , and appropriate technology , from a number of countries .

Local builder trainees who were selected from Chikal and neighbouring villages participated in the workshop . Architects of the Development Workshop were the instructors .

IV. Construction Schedule and Cost

History

April 1979 - August 1980 : Programme development phase .

October 1980 - November 1980 : Design phase .

November 1980 - December 1980 : Construction workshop .

December 1980 : Project occupancy .

Costs

The total initial budget is open ended . The Literacy Centre construction cost , 100% from public international sources , was US\$8,403 in 1980 .

Land	0%			
Materials	10%	280,000	FCFA	= US\$ 1,157
Labour	13%	350,000	FCFA	= US\$ 1,446
Prof-fees	77%	-		US\$ 5,800
TOTAL	:			US\$ 8,403

Note : US\$ 1 = 242 FCFA (1980)

V. Technical Assessment (1)

The Literacy Centre

The composition , orientation and volumes are well adapted to climatic conditions , the building is flexible in its functional aspect and well maintained .

(1) See also Annexes X. and XIII.

The latest modifications are relevant to the socio climatic conditions , with the exception of the closing of the windcatcher , which could also have a window in order to be used during rain .

PTV Construction and Technology

A variety of techniques have been used in foundations , walls , roofs , and rendering .

Foundations : Literacy Centre ; laterite rock set in soil sediment and two courses of soil cement blocks.

Meteorological station ; reinforced concrete footings and laterite rocks set in concrete and cast concrete pad .

All other buildings ; banco bricks set in banco mortar (banco prepared traditonally).

Walls and
Roofs

: Except in the case of the Literacy Centre (where two courses of soil cement blocks were used) , only Banco bricks with local binders such as cow dung , horse manure and millet chaff are used . The project has introduced some improvements in brick moulding .

Renderers : In some examples , the traditional banco and dung renders have protected buildings for two years without problem . However , such renders do need constant repair and improvements . Other techniques have also been tried , such as waste engine oil , which provided excellent resistance to rain and termites . Acacia juice , sand , and clay had a good resistance to rain . For soil , various mixtures have been tested , in particular a mixture of sand and clay , and 5% cement , which was used on the Literacy Building roof.

In its ecological objectives the project has been successful in building without wood . However , organic material is still used in the manufacturing of bricks . This is a double problem as the organic matter is better but it also encourages termites in the bricks . Pressed bricks with or without a stabilizer may be a solution , and hand made banco blocks with additional sand in the mixture to control crack-ing may also be useful but will need good render protection.

The building erected (from pure banco brick to banco brick finished in " semi-dur") has proven to be structurally sound and able to provide protection and comfort in this climate .

Costs

Because of the volunteer work and irregular working hours , a comparative cost study is difficult . However , a traditional roof constructed with beams , sticks and banco

costs 1281 FCFA/sq.m. (US\$ 3.53) ; vaulted roofing methods cost 435 FCFA/sq.m. (US\$ 1.20) , which is 66% less expensive .

Although the traditional roofing method requires 20 cm thick bearing walls, and the vaulted roofing method requires 40 cm thick bearing walls , the actual cost becomes less expensive using the vaulted method construction because of amount saved in the roofing and particularly from reduced main-tenance costs (with traditional roof the timbers are often replaced after a few years and in some cases after one year.

Project Impact

By making it possible to build without wood , the project has started to develop an ecologically conscious building method. As a result , there is again a demand for training in the techniques , and in the context of PTV's development Phase III , a second training program will be directed by the Development Workshop architects in Chikal .

PTV building activities in general have resulted in numerous spinoffs , which indicate that some of the original objectives of the program have in varying degrees been fulfilled.

The local population , and in particular , government agencies , have taken note of these activities and have expressed a willingness to pursue research and action at their own levels .

The Ministry of Public Works (Travaux Publics) is primarily concerned with urban housing (1) , yet the problems of economics , waterproofing , and durability are similar to those in the villages .

The Ministry of Rural Engineering (Genie Rural) is also interested in this topic , as well as in finding more economical construction methods for the large buildings they put up throughout rural Niger .

The Ministry of Agriculture would like to build a station similar to Chikal's in an area of northern Niger .

Future Directions

On a local level , PTV will search for new ways to encourage villagers to look more closely at these ancient , but improved , techniques of construction . The team will observe the buildings already constructed for durability , problems , and local acceptance . The project will also continue to do comparative cost analysis of the traditional

(1) PTV , in its Phase III construction program , will attempt to make the vault and dome techniques accessible on a national level , see also Annex VIII.

See Also Annex XIII , (Fiche technique vulgarisation) .

and the improved methods ; investigate ways to reduce the amount of materials needed in the construction ; better methods for rendering the buildings to make them last longer ; and consider different designs that are more acceptable to all types of people .

VI. Aesthetic Evaluation

The design is simple : basic volumes without visual rigidity , well integrated , and homogeneous with the immediate environment .

VII. Project Significance

The Literacy Centre building is one of the results of a long collaborative effort aimed at upgrading living conditions in one of the numerous areas of West Africa that suffers desertification .

The project is symbolic and significant because of its socio-ecological aspect , and particularly , its integrated approach methodology , which relies on community participation and training , easily adaptable to any similar situation .

Technical Reviewer : Yekta CHAHROUZI
May 1983

List of Annexes

- I. Literacy Centre - Design concept
- II. Building Training Workshop and Construction
- III. Climate Analysis for Chikal , Niger
- IV. Deveopment Workshop
- V. A General Statement of "ISAID" Plans in Sahel Region of West Africa , 1983-1984 , ISAID , February , 1983
- VI. Un bref historique du Projet Tapis Vert , 1982
- VII. Projet Tapis Vert, "ISAID" , Toronto , October 1982
- VIII. Republique du Niger , Ministère de l'Enseignement supérieur et de la Recherche , Institut national de Recherches agronomiques du Niger

Projet Tapis Vert : synthèse des résultats de la première et deuxième phase du projet .

programme de la troisième phase.
- IX. Republique du Niger , Ministère de l'Enseignement supérieur et de la Recherche , Institut national de Recherches agronomiques du Niger .

Projet Tapis Vert : Etude sociologique réalisée à Chikal , October 1982
- X. Republique du Niger , Ministère de Travaux publiques et de l'Urbanisme , Service central de l'Habitat et de l'Architecture :

Rapport d'Evaluation des techniques de construction (voûte , dômes) du projet Tapis Vert .
- XI. Projet Tapis Vert : Programme de construction
- XII. Republique du Niger , Ministère des Travaux public , des Transports et de l'Urbanisme , Direction de la Météorologie nationale :

Station agrometeorologique de Chikal projet PNUD/OMM/NER/77/002
- XIII. Fiche technique , Vulgarisation
- XIV. Ganga : No. 39 , December 1982
- XV. Plans :
 1. Plan of Niger
 2. Regional Plan
 3. Location of "PTV" project activities

PROJECT BASIC FACT SHEET

1. 1.1 Country : Niger
- 1.2 Project : The Chikal Village Literacy Centre
- 1.3 Architect : Development Workshop (PTV Group) , Niger
- 1.4 Dates of i) design : October 1980 - November 1980
ii) construction : November 1980 - December 1980
2. 2.1 Project Description : As part of an interdisciplinary and integrated approach for the development of a typical Sahelien village , the Literacy Centre was built to meet community needs while offering an opportunity to introduce new design elements and test the appropriate technology .
- 2.2 Project Objectives : To investigate solutions to reduce or eliminate the use of wood in buildings; to improve local building technology and skills; and to develop the utilisation of local resources , by promoting community participation and intensive training of local builders.
- 2.3 Description of Site and surroundings : Located on the eastern side of the Dallot Rosso, 18 km from the town of Filingue , the area is typical of the drought-stricken regions of West Africa .The Literacy Centre site is located at Chinyassou Village .
3. 3.1 Site Area : 225 sq.m. (0,225 ha.)
- 3.2 Building Area : 40 sq.m.
- 3.3 Building Materials & Techniques (identifying whether self-help or not) Self-help
 - i) Foundations : Laterite rock set in soil cement and 2 courses of soil cement blocks .
 - ii) Walls : Mud block bearing walls (using improved techniques)
 - iii) Roofing : Vault and dome , protected by a mixture of sand & clay plus 5% cement . A cooling system was introduced employing a wind-catcher.
 - iv) Other special : A new render was developed , using features (if any) crushed acacia pods in a stabilizing plaster.
- 3.4 Beneficiaries : Number of persons: Chinyassou Village population (3.075), 48,89% of Chikal Population (6.289)

Type of persons (socio/econ. level, etc.): The main activity of the Chikal population is agriculture .

4. Costs	4.1 Budget	:	\$ <u>Open-ended</u> (1979) = \$ _____ (1983)
	4.2 Actual (tot.)	:	\$ <u>8403</u> (1980) = \$ <u>7674</u> (1983)
	4.3 Breakdown of Actual Costs :		
	Land	:	<u>0</u> (1980) = \$ <u>0</u> (1983)
	Infrastructure	:	\$ <u>-</u> (1980) = \$ <u>-</u> (1983)
	Building	:	\$ <u>2603</u> (1980) = \$ <u>1874</u> (1983)
			<u>630,000 FCFA</u> <u>680,000 FCFA</u>
	Pro.Fees (expatriates)	:	\$ 5800 \$5800
	TOTAL	:	\$ <u>8403</u> (1980) = \$ <u>7674</u> (1983)

4.4 Unit Cost

- i) Unit Cost of Building : \$ 65/sq.m. (1980) = \$47/sq.m. (1983) (excl.Prof.fees)
- 15,750 FCFA = 17,000 FCFA

Compares with present range in country of :

High : \$ 964 (350,000 FCFA) / sq.m. (1983)
 Medium: \$ 467 (169,500 FCFA) / sq.m. (1983)
 Low : \$ 22 (8,000 FCFA) / sq.m. (1983)
 (Primary school and low cost housing)

- ii) Actual Total Cost of Housing Unit in US\$ 1983 (in Niamey)

(Actual Cost : Number of Units

Land : \$0.70
 \$1.98 (with water & electricity)
 Infrastructure : \$ 0% to 0% (1983)
 (of construction cost)

Building : H. \$165 (60,000 FCFA) , 1983
 M. \$ 55 (20,000 FCFA) , 1983
 L. \$ 22 (8,000 FCFA) , 1983

TOTAL : \$ _____ , 1983

5. Country Economic Data

- 5.1 Per capita income : \$ 337 (1982) p.a.
- 5.2 Average Household income : \$ _____ (1983) p.a.
 \$ _____ (1983) p.mo.
- 5.3 Poverty thresholds : \$ 58 (21,000 FCFA), 1983
 (per household per month)
- 5.4 Project beneficiaries :
 Average household income level
 : \$ 0/marginal (or self sufficient)
 (per household per month)

Note : Inflation rate estimation between December 1980 and May 1983 is 8% (for Chikal area)
 Exchange rate in 1980 was 242 FCFA = US\$ 1
 and in May 1983 was 363 FCFA = US\$ 1