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Appropriate Rural Technology

FOR THE

YEMEN ARAB REPUBLIC

PREPARED FOR
THE GOVERNMENT OF THE
YEMEN ARAB REPUBLIC
AND THE UNITED STATES
A.I.D. MISSION TO THE
YEMEN ARAB REPUBLIC

PREPARED BY
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WASHINGTON, D. C. 20036

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APPROPRIATE RURAL TECHNOLOGY
FOR THE
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Prepared for

The Government of the Yemen Arab Republic

and the

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Contract AID/otr-C-1378

Work Order No. 14

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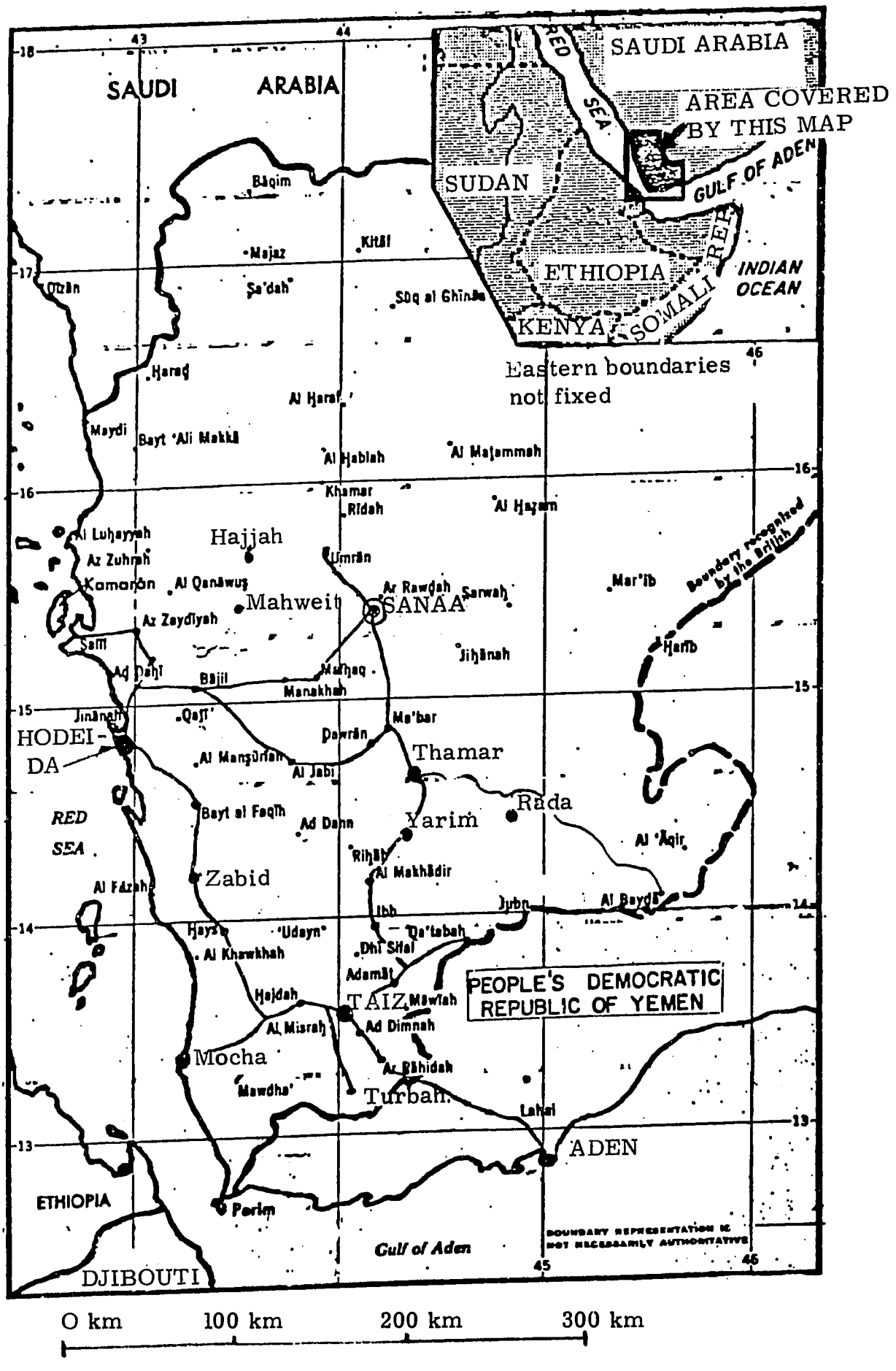
YEMEN ARAB REPUBLIC



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The upper picture shows shorghum, one of the principal carbohydrate foods along with millet. The lower picture shows millet; both are ready for harvesting.

ABBREVIATIONS AND GLOSSARY OF SPECIALIZED TERMS USED IN YEMEN ARAB REPUBLIC

ACB	Agricultural Credit Bank
AEP	British-Yemeni Agricultural Engineering Project (Taiz) (training in farm machinery, evaluation)
AID	Agency for International Development, Department of State
Aguil	(village) headman
Akhdam	Performers of certain low status jobs. See Khadim
CARS	Central Agricultural Research Station
CB	Central Bank
CDSS	Country Development Strategy Statement (AID terminology)
CGC	Cotton General Co. (buys all local cotton; distributes farm inputs to cotton growers, a government agency)
CPO	Central Planning Office of Prime Minister Office
CRS	Catholic Relief Service
CYDA	Confederation of Yemeni Development Associations (national level for LDA's)
DAP	Development Assistance Plan (obsolete AID term; see CDSS)
Durra	Sorghum
ECWA	Economic Commission for West Asia
FAO	Food and Agriculture Organization of the United Nations
FRG	Federal Republic of Germany (West Germany; finances agriculture project at Amran) and others; paved highway from Sanaa to Taiz.

Funduq	Hotel
GDP	Gross Domestic Product
Governorate	Political subdivision in Yemen of which there are ten in all
Gwh	Gigawatt hour, i.e., 10^6 Kwh
ha	hectare = 2.47 acres
HC	Host Country
H.M.I.	W.H.O.-sponsored Health Manpower Institute, in Ministry of Health. There are branches in Sanaa, Hodeidah and Taiz
IDA	International Development Administration (of World Bank)
IDCAC	Industrial Development Centre for Arab Countries (Cairo)
Imam	Prayer leader in mosque. Also serves as circumciser. Another meaning: former theocratic kings, deposed by September 26, 1962 revolution
IVS	International Voluntary Services
jambia or janbiyyah	Curved knife in leather sheath worn in belt at front by Yemeni males
Kada	Volumetric measure of produce, about 23-35 kg of barley or beans
KFAED	Kuwait Fund for Arab Economic Development
Khubz	One of main carbohydrate staple foods, an Arab flat bread made from sorghum or wheat-sorghum flour
Kahdim (pl. akhdam or kadima)	Member of a low status group who perform certain menial jobs such as servants, cleaners and vegetable growers
Kw(h)	Kilowatt (hour)
LDA	Local Development Association (at town and village level)
LDACC	Local Development Association Coordinating Committees (in each governorate)
LDC	less developed country

libna	.012 acre or about 1/100th acre
Lucerne	alfalfa
Ma'ad	100 libna or about 1 acre
mada'ah	Indian-style pipe for smoking tobacco, with smoke cooled by water
Madfan	Storage room for cereals cut out of rock
Medina	Non-modernized section of Arab cities, sometimes walled for security, also "old city"
MFRA	Mineral and Petroleum Resources Authority (government agency established by decree 1973)
Muezzin, muethin	Announcer of prayer time, usually calls from minaret, often through loud speaker. Also may be circumciser
Mullah	Muslim religious teacher or priest
MW(h)	Megawatt (hour), i.e., 1000 watts
nahiya	district-subdivision of a governorate
NIPA	National Institute of Public Administration
ODM	British Ministry of Overseas Development
OPEC	Organization of Petroleum Exporting Countries
P/M	Person months
Qabilah	tribe
Qadi	A lerned Islamic scholar
qat	Leaves of the shrub, or sometimes tree, Catha edulis which produce a stimulating effect when chewed due to an amphetamine-like constituent. These leaves are widely used in Yemen to relax in the afternoon or on social occasions.
RD	Rural development
Sambuks	Motorized fishing boats 5-10 tons capacity, inboard engine

Sayyid or Sharif	Descendent of the Prophet (Mohammed)
Sharik	sharecropper
Sheikh or Shaikh	Local community leader
Spate irrigation	Irrigation only when rivers or streams are flooding; as distinguished from perennial irrigation
Suq	Marketplace. In large cities, there are permanent suqs. In rural areas, suqs are held only on certain days.
SURDU	Southern Uplands Rural Development
TAIC	Thamar Agricultural Improvement Center
Tajir	leading merchant
TDA	Tihama Development Authority (World Bank-financed)
Tihama	Strip of flat coastal land, 40 km wide extending along the Yemen Red Sea coast
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization (Vienna, Austria)
USAID	Denotes AID Mission in Sanaa; see also AID
Wadi	River valley, stream channel
YARG	Yemen Arab Republic Government
YBRD	Yemen Bank for Reconstruction and Development
YGEC	Yemen General Electricity Corp. (created 1975)
YNPC	Yemen National Petroleum Company
YR or YRL	Yemeni rial = US$0.22; YR 4.5 = 1 $US
Zakat	Tax on agricultural produce, shared by government and L.D.A.

CHAPTER 1

INTRODUCTION AND SUMMARY

1.0 Introduction

This report proposes a project whereby appropriate rural technologies would be introduced into the Yemen Arab Republic over a three-year period.

The terminology "appropriate rural technology," as used herein, means (a) specific machinery or equipment such as a tractor, plow, pump or water filter or (b) a process or arrangement for carrying out an activity such as irrigation, waste collection, improved home sanitation, hauling of water for home use, or the construction of house roofs.

Data for this report were collected by a research team of four persons who visited the YAR over a period of six weeks from August 30 to October 10, 1978, under a contract between AID and Checchi and Company, a consulting firm based in Washington, D. C. The research team was composed of the following persons:

1. Frank L. Turner, Agricultural Development Economist
2. Harry G. Clement, Economist and Small-scale Industry Advisor
3. Joan M. Campbell, Rural Sociologist
4. Joseph E. Stepanek, Appropriate Technology Policy Advisor

The objective of the survey and the report herewith was to provide information in sufficient detail for AID to consider the desirability of financing a technical assistance project.

The purpose of the project proposed herein would be to establish an institution which would gradually re-direct Yemen's foreign exchange expenditures toward the purchase of farm-related equipment that is better suited to Yemeni conditions than the equipment now being imported.

The institution would also encourage importers of agricultural machinery to strengthen their programs of product support. That is, expand inventories of spare parts, extend their repair activities to the rural hinterlands (where 80 percent of the populace resides), and upgrade the training of machinery operators.

The institution would seek to improve Yemeni housing, improve home appliances, and raise standards of sanitation in homes and rural communities. The report points out that the subservient position of women in Yemeni society will retard the achievement of changes in home and health conditions, but that these conditions--virtually unchanged for thousands of years--are a major cause of the high infant mortality rate (about 50 percent) and contributing to the high incidence of diseases

Summary of This Report

1.1.1 Remittances from Abroad and Imports are Accelerating Change

Until 1970, the end of an eight-year civil war, Yemen was largely isolated from the outside world as a matter of national policy. Institutions, the position of women, public health, sanitation, illiteracy, transportation and agricultural practices had remained virtually unchanged since Biblical times.

With the overthrow (in 1970) of the Imamate--Yemen's former theocratic ruling group--Yemeni society and the economy began to undergo rapid changes. Fueling these changes more than all else has been the flow of money sent into Yemen by emigre Yemeni workmen. This inflow, called remittances, is reaching the grass roots of Yemeni society, and rural inhabitants are often spending their new wealth in a wasteful manner. At the same time, the suppliers of equipment (importers) are unable to cope with problems of maintenance and spare parts. As a result, about one-third of the tractor fleet remains idle.

The availability of money from remittances has allowed the level of Yemeni imports to float upward at a pace similar to the growth in remittances, as tabulated below:

GROWTH OF INWARD REMITTANCES FROM YEMENI WORKMEN ABROAD
AS COMPARED WITH YEMENI IMPORTS
(in millions of U.S. dollars converted from Yemeni rials)

Years Ending June 30	Inward Remittances	Imports
1973/74	$ 132	$ 166
1974/75	225	218
1975/76	525	379
1976/77	1,013	674
1977/78	1,340	1,377

1.1.2 Outlook for the Remittance Windfall

The bulk of the remittances originate in Saudi Arabia where execution of the First Five Year Development Plan has gathered momentum since 1975. This means that the Saudis (since that time) have been spending billions of dollars annually for the construction of roads, hospitals, office buildings, housing, schools, ports, and airfields. (The largest airfield in the world is under construction near Jiddah.)

The Yemeni workers, although unskilled, are appreciated in Saudi Arabia. This is because of their dilligence, availability, understanding of Arabic, and their ready ability to assimilate themselves into a cultural and physical setting similar to their own. An estimated 600,000 Yemeni workmen are now engaged in Suadi Arabian projects.

In general, the economic outlook is for a continuation of Yemeni earnings from the export of labor and from a rising gross domestic product (GDP), increasing at about eight percent annually. The inward remittances, plus the domestic product, have resulted in a gross national product (GNP) of about $2.7 billion--or $487 per capita, assuming a total population (including Yemeni workmen abroad) of 5,460,000 in the year ending June 30, 1978.

However, the remittance windfall may not last as the pace of Saudi Arabian development subsides. At the same time, the Yemeni appetite for imports is rising at rates faster than the increase in remittances. Imports in 1977/78 had risen to $1.4 billion, an increase of 104 percent over the prior year. Remittances in 1977/78 rose to $1.3 billion, an increase of 32 percent over the prior year.

Wages in Yemen are moving upward in sympathy with wages in Saudi Arabia (a three-fold increase since 1974), so that an unskilled worker in Yemen earns up to the equivalent of $15.55 per day, as compared with $22.22 per day in Saudi Arabia.

A lessening of remittance revenue or a continued upsurge of imports will leave the fragile Yemeni economy in a precarious position.

1.1.3 Proposed Project to Reduce Waste of Financial Resources and Raise Productivity

This report suggests a project which could strengthen some of the inherent weaknesses and reduce waste in the Yemeni economy, thereby fortifying the nation for the day when the current affluence declines. The project, if successful, would help to build a tradition for greater prudence in the selection of imported equipment--that is, the selection of farm-related equipment that is appropriate for Yemeni conditions. The project could also help to improve the performance of Yemeni importers in farm machinery maintenance and a build-up of spare parts inventories in the rural hinterlands where 80 percent of the population resides.

The program would hopefully begin a process whereby Yemeni homes would become more sanitary and liveable and women of the household would find themselves freer to enter the economy and alleviate the acute labor shortage that is dragging down national productivity. About 44 percent of Yemen's male labor force is working abroad, resulting in a neglect of farm maintenance and a greater burden on women.

The project would help speed the process of improving sanitation in rural homes and communities. The typical bathroom in Yemeni rural homes consists of two holes--one for urine and one for excrement. Both materials, along with animal dung, collect on the street below and enter the run-off flowing into community cisterns. With the widening ownership of TV and radio receivers, and with more contact with the world outside, deplorable sanitation will not be tolerated for long.

Yemeni agricultural productivity has declined in recent years due, in part, to drought conditions and, in part, to the shortage of farm labor and the abandonment of marginal lands. The introduction of labor-saving equipment for soil preparation, harvesting and processing could bring about improvements in farm output.

1.1.4 Administration and Functions of the Project

The project would be carried out under administrative arrangements with the Ministry of Economy and would be physically based in Sanaa but would have an impact throughout the Republic. Working with Yemeni counterparts would be a resident expatriate staff of four persons supported by about eight short-term (TDY) specialists and assisted by about 20 participants sent overseas during the three-year duration of the project.

The purpose of the expatriate staff would be to build an institution, tentatively called the Yemen Appropriate Rural Technology Authority (YARTA). The YARTA would carry out the following tasks:

A. Conduct a search of the findings of at least 24 organizations concerned with appropriate technology (e.g., A. T. International, Intermediate Technology Group of London, the AID-financed Appropriate Technology Office in the Pakistani Government, the AID-financed ITINTEC program in Peru, and others). The search would concentrate on rural technologies appropriate for arid, mountainous, labor-deficit countries with a tradition for the social and economic isolation of women. In order to be of manageable proportions, the search (as well as the project itself) would concentrate on three areas only:

1. Agricultural production and transport of farm products to markets

2. Home and health improvements

3. Agricultural product processing and the repair of equipment used in rural areas.

B. Establish an R & D laboratory in Sanaa for the testing of equipment considered promising for Yemen and the building of prototypes.

C. Select equipment and processes developed elsewhere that appear to be promising for Yemen. The selection would be made in accordance with economic and social criteria agreed to in advance with the Yemen Arab Republic Government (YARG).

D. Maintain a continuous dialogue of Yemeni importers of machinery and with donor agencies. The importers and donor agencies would undertake field testing and make recommendations to YARTA so that the latter would play a primarily coordinating, rather than an operational, role.

E. Discuss with the YARG the adoption of policies whereby the importing and consuming sectors of the economy would have incentives to select better types of equipment, to improve maintenance and parts inventories, and to take steps to make Yemeni houses and villages more healthy and liveable.

1.1.5 Measuring Performance of the Project

The success of the YARTA would have to be measured in quantitative terms, e.g., the number of technologies screened for suitability, the number tested in Yemen, the number actually used by an appreciable number of farmers and households. Targets of 15 technologies in agriculture, ten in home and health improvements, and ten in the processing of farm products and in the repair of equipment are suggested.

1.1.6 Cost of the Proposed Project

The project budget proposed in this report (Chapter 6), over a three-year period, is $3,370 thousand. This would support four long-term technicians, eight TDY technicians, 20 participants, the cost of an R & D laboratory (the nucleus of a central research laboratory for the YAR), plus commodities for demonstration and testing.

1.1.7 Reasons for an Appropriate Technology Project

Within the space of two years (ending June 30, 1978), Yemen's imports of machinery rose from the equivalent of $64 million to $404 million. There is no attempt being made to screen or influence the composition of these imports so as to contribute to national economic goals.

The imposition of controls through import licensing, customs duties, quota restrictions, or allocations of foreign exchange would probably backfire due to the existence of open frontiers and the tradition of free choices, deeply entrenched in the importing and consuming communities.

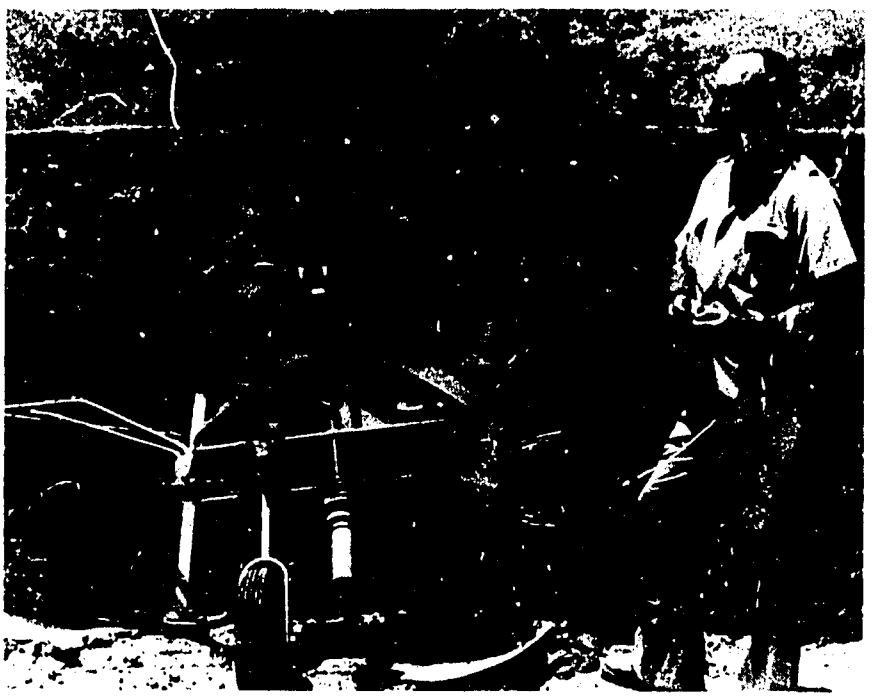
A program of consumer education and a systematic dialogue with importers of machinery is needed (a) to improve the suitability of the imported products, (b) to take advantage of R & D that has occurred in industrialized countries (the United States, Europe and Japan), and (c) to change the throw-away attitude toward machinery now prevailing in Yemen. In place of this attitude, there should be a growing public awareness of the need for preventive maintenance, product support, and the upgrading of machine-related skills.

The upsurge of machinery imports began in 1976. This means that much of the farm machinery is in its third year of operation. Diesel engines for pumps, tractors, generators and trucks, are rapidly depreciating giving rise to a need for intensified maintenance and the upgrading of skills.

Despite the superficial indicators of modernization, Yemeni homes and villages are still characterized by egregiously bad sanitation and inefficiencies in work arrangements for women. Because 44 percent of the male labor force is working abroad, farm productivity has declined and action is needed to facilitate the entry of women into economic life.

Importers of machinery, individual farmers, rural women, the Local Development Associations (LDAs), and the central government in Sanaa are interested in appropriate technology. This interest, plus the rising use of TV and radio and the availability of cash to spend, make the outlook for introducing appropriate technology highly promising.

Potato digger being developed by the Yemeni/British Agricultural Engineering Project, Taiz.



Sorghum stalk chopper being developed by the Yemeni/British Agricultural Engineering Project, Taiz. Chopped stocks are used for feeding bullocks, donkeys, and camels.

CHAPTER 2

APPRAISAL OF THE POTENTIAL FOR APPROPRIATE TECHNOLOGY

2.0 Economic and Social Factors Affecting Technology

2.1 The Role of Remittances

The economy of Yemen is changing rapidly, propelled upward since 1973 by the inward flow of remittances sent to families by Yemeni workers outside the country.

The bulk of these remittances originate in Saudi Arabia where most of the 600,000 estimated emigre workers are employed. The Saudi Arabian Five Year Plan calls for the investment of billions of dollars annually, primarily in roads, ports, airports, office and residential buildings and increasingly in oil-related industrial projects. There appears to be no end in sight except for the ultimate decline in oil revenues projected by some analysts to begin in 2000 or beyond. Even such a decline is being pushed further into the future as the OAPEC countries are rationing oil production to prolong the life of their reserves, the world's largest. At the same time, other oil reserves in the Arabian Peninsula, once considered marginal, are being explored because of today's prices.

The Central Bank of Yemen's records show "private transfers" from abroad and these consist almost entirely of remittances from Yemeni workmen. The recent year record of remittances is tabulated below (the years shown are 12-month periods ending June 30).

Table 2.1

INWARD REMITTANCES FROM YEMENI WORKMEN ABROAD

1973/74 to 1977/78

(Units: as stated in column headings)

	Yemeni Rials, Millions	Converted to Equivalent in U.S. $ Millions	Change Over Prior Year
1973/74	YR 595	132	--
1974/75	YR 1,013	225	70%
1975/76	YR 2,363	525	133%
1976/77	YR 4,561	1,013	93%
1977/78	YR 6,030	1,340	32%

Source: Central Bank of Yemen
(Exchange rate is YR 4.5 = US$ 1.00)

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To assess the role of remittances, we have selected the year 1976/77 for which other data are available for comparison purposes. The remittance figure for 1976/77 was $1,013 million. The remittances at $1,013 million in 1976/77 were larger than the value of imports and larger than the total money supply. The figure of $1,013 million was 84 percent of all invisible receipts, and 82 percent of the gross domestic product in 1976/77, as shown below:

Remittances as a Percentage of:		
Value of imports (1976/77)	139%	($1,013 million/$730 million)
Value of all invisible receipts (1976/77)	84%	($1,013 million/$1,212 million)
Outstanding foreign debt as of March 31, 1978)	276%	($1,013 million/$367.2 million)
Currency in circulation (as of June 30, 1977)	149%	($1,013 million/$682 million)
Money supply (currency in circulation, demand and time deposits as of June 30, 1977)	104%	($1,013 million/$971.2 million)
Gross domestic product (1976/77)	82%	(1,013 million/$1,236 million)

Source: Derived from Central Bank of Yemen, Jan.-Mar. 1978 Financial Statistical Bulletin, and from the First Five Year Plan, via the Economic Commission for Western Asia.

The above data may understate the value of remittances because cash, cars, trucks, and tractors are brought into Yemen purchased by workers abroad.

2.2 Distribution of Remittances

There are some indicators of a slightly uneven geographical distribution as between regions owing to the fact that the numbers of emigrants vary by region. A Swiss survey in 1975 showed that the largest number of emigrant workers, 73,385, originated in the Governorate of Ibb, 45 km north of Taiz, in that year. The second largest number, 72,289, originated from Taiz. The third largest number and a distant

third, amounted to 35,052 emigrants from the Red Sea port of Hodeida. The fewest number of emigrants in 1975 went from the Governorate of Marib, about 100 km east of Sanaa in the sparsely populated desert region bordering on the Peoples Democratic Republic of Yemen.

However, these differences in numbers when viewed in the context of the population of each region show that the emigrants per person is fairly even, averaging 6.5 emigrants per capita in 1975.

This means that the inflow of earnings abroad is reaching all of the governorates. The fact that these earnings are generated by unskilled labor suggests that the wealth is originating at the bottom of the social structure and filtering upwards when the money is used for such purposes as the construction of housing and the import of vehicles or machinery.

2.3 The Future of Remittances

There are forces at work that suggest Yemen's emigre labor should continue to find employment in Saudi Arabia and in the other oil-producing states of the Peninsula: (a) the Yemeni speak Arabic and can be instructed more readily by Arab employers than the workers from Bangladesh, the Philippines, Pakistan or India; (b) the oil-producing Arab states have a vested interest in Yemen's prosperity and continued presence as a buffer between them and the Yemen Democratic Republic of the South; (c) geographically close at hand, the Yemeni work force is a convenient reservoir of manpower that can be quickly tapped to meet surges in the demand for labor or can be sent home readily if the work is finished; (d) the Yemeni workman tends to be diligent and is content to work in the familiar cultural, religious, and climatic conditions that exist in Saudi Arabia.

The Government of Yemen has been concerned about the impact of emigration, particularly the resulting labor shortage, the delays in implementing projects under Yemen's own Five Year Plan and the inflationary effect of high wages. From time to time, restrictions on emigration have been considered but have not been implemented. Restrictions would probably not be enforceable because the border between the YAR and Saudi Arabia is open, Saudi Arabia requires no passports from Yemeni workmen, and most currencies, including Saudi and Yemeni rials, dollars, francs, marks, and sterling are freely convertible.

Despite certain undesirable effects of emigration, we make the assumption that emigration will probably continue, but that the annual growth rate in remittances will slowly decline as high wages in Yemen itself will begin to retard the flow of migrants to Saudi Arabia.

At the same time, the volatile history of the Middle East suggests that unforeseen changes could occur at any time. Wars or political realignments could occur and the present windfall of remittances could decline. In that case, Yemen's economy would be left quite defenseless. A prudent approach to the future suggests that steps be taken to make the best use of the revenue now available and to fortify the economy by a program to assure the introduction of appropriate machinery and the improvement of preventive maintenance. Reasons for such a program are described in Section 2.16 below.

2.4 Trends in Yemeni Wages

As compared with wages for unskilled labor in Saudi Arabia, wages in Yemen are now (October 1978) almost as high. An unskilled, male farm workman in Yemen receives YR 60 to YR 70 ($13.33 to $15.55) per day, whereas in Saudi Arabia he would receive the equivalent of YR 80 to YR 100 ($17.78 to $22.22) per day. Wage levels for Yemen have risen about three-fold since 1974; in that year, the unskilled male would have earned YR 20 to YR 25.

Other examples of 1978 wages in Yemen are as follows:

Table 2.4

OCTOBER 1978 WAGES PAID IN SANAA

	YR Per Day	YR Per 300-Day Year	U.S. $ Equivalent
Stone mason	350	105,000	23,333
Senior carpenter	400	120,000	26,666
Jr. Carpenter (18-24 years old)	200	60,000	13,333
Electrician who installs light fixtures and wiring	420	126,000	28,000
Small-scale factory drill punch operator, senior	208	62,400	13,867
Women spindle operators in Government cotton mill	25	7,500	1,667
Street cleaner (akhdam)	68	20,400	4,533
Stone chipper (smoothing outer surface)	468	140,400 (6 stones/hour for 6 hours per day x 300)	31,200

However, even though Yemeni wages are approaching the Saudi level, there are usually more work opportunities in Saudi than in Yemen. In Saudi Arabia, workers often put in a 12-hour or even 18-hour day, and as one job ends, another opens up.

The Yemeni worker is attracted by the opportunity to work in Saudi Arabia for a further reason, the opportunity to save money. While in Saudi Arabia, his housing and food cost very little; there are few opportunities for entertainment, and above all, the worker cannot spend money on qat, the mild narcotic leaf which can cost from ten to thirty percent of his wages while in Yemen. This situation will continue to lure the Yemeni workman who typically stays long enough in Saudi to save money to buy a house in Yemen or to pay for a bride.

2.5 Remittances Projected to 2000/2001

The annual growth rate in remittances has already declined from 133 percent in 1975/76 to 93 percent in the following year, and to 32 percent in 1977/78. (See Table 2.1 above.)

There are several projections available in the literature on Yemen (see Louis Berger International in the bibliography at the back of this report, Annex D). Some projections assume a 45.8 percent annual average growth to the year 2000/1; others assume a rapid fall-off in the growth rate to only six percent. Based largely on the past, our judgment is that the probable trend will come to rest between the above extremes, dropping to 15 percent annually by 1978/79 and to six percent for the decade preceding the year 2000/2001 as tabulated below. This assumes continued economic and political stability in the area.

Table 2.5

PROJECTION OF INWARD REMITTANCES TO YEMEN, 1976/77-2000/2001
(Units: as stated in column headings;
figures are in constant 1976/77 prices)

Years Ending June 30	(A) YR Millions	(B) Column A Converted to U.S. Dollars, Millions	(C) Annual Growth Rate (%)
1976/77	4,560	1,013	93
1977/78	6,030	1,340	32
1978/79	6,811	1,514	15
1979/80	7,628	1,695	12
1980/81	8,315	1,848	9
2000/2001	14,890	3,309	6

2.6 Projections of Gross Domestic Product

The First Five Year Plan projects growth in GDP at eight percent (actually 8.16) from 1976 to 1981. With an acceleration to nine percent, we project that GDP and per capita GDP may unfold in the following pattern. A decline in the population growth rate to two percent is forecast for the decade preceding the year 2000/2001:

Table 2.6

PROJECTION OF GROSS DOMESTIC PRODUCT TOTAL AND PER CAPITA
1976/77 to 2000/2001
(in constant 1976/77 prices)

Years Ending June 30	Population (000's)	GDP (U.S. $ Millions) (growth rate)		Per Capita GDP
1976/77	5,310	1,236	(-)	$ 233
1977/78	5,460	1,345	(8%)	246
1978/79	5,591	1,442	(8%)	258
1979/80	5,725	1,571	(9%)	274
1980/81	5,863	1,723	(9%)	294
2000/2001	7.147	3,086	(6%)	432

(2% annual growth from 1980/81 to 2000/2001)

GDP allocated by sector is shown in the following table:

Table 2.6.1

GDP ALLOCATED BY SECTOR - 1975/76 and 1976/77

	1975/76 Value (YR Millions)		1976/77 Value (YR Millions)
Agriculture	2,305	(45%)	2,365
Industry	302	(6%)	330
Building and Construction	227	(4%)	239
Transport and Communications	151	(3%)	163
Trade	1,220	(23%)	1,388
Finance and Banking	141	(3%)	175
Housing	199	(4%)	205
Government	509	(10%)	562
Services, Other	127	(2%)	135
TOTAL	5,181	(100%)	5,562

Source: Fifth Five-Year Plan for 1975/76; 1976/77 calculated from Plan growth rates.

2.7 Projections of Gross National Product

Combining the resources of both external and domestic origin, the per capita GNP could unfold as follows:

Table 2.7

PROJECTION OF GROSS NATIONAL PRODUCT (GNP)
1976/77 to 2000/2001, TOTAL AND PER CAPITA
(Units as stated in column headings;
prices and figures are in constant 1976/77 prices)

Years Ending June 30	(A) GDP (U.S. $, millions)	(B) Remittances (U.S. $, millions)	(C) GNP (A + B)	(D) Population (000's)	(E) Per Capita GNP ($)
1976/77	1,236	1,013	2,249	5,310	424
1977/78	1,345	1,316	2,661	5,460	487
1978/79	1,442	1,514	2,956	5,591	529
1979/80	1,571	1,695	5,266	5,725	570
1980/81	1,723	1,848	3,571	5,863	609
2000/2001	2,086	3,309	6,395	7.147	895

2.8 The Statistical Appearance of Comparative Wealth

Judging by statistics, Yemen would appear to be one of the wealthiest countries of the developing world. Its per capita GNP in 1975 was about $329 ($1,722 million divided by 5,240,000 people). This figure would classify Yemen along with the following countries also for 1975:

Country	Per Capita GNP
Nigeria	$340
China (People's)	380
Philippines	380
Thailand	350
Honduras	360
St. Vincent (West Indies)	420
Guyana	400

Source: World Bank Atlas, 1977.

However, there are several reasons why Yemen's economy does not in fact reflect the statistics.

Yemen has only emerged from a long period of isolation from the outside world as the Imamate was replaced by the Republic at the end of the eight-year civil war in 1970. As recently as 1972, per capita GNP was only $110 ($548 million/5 million people). The remittance flows began to gain momentum after 1973 in the wake of the oil price escalation of December 1973. This money, now contributing to the statistical upsurge in GNP, is in part being misused and, in part, it is not being used at all. For example, as of January 1978, only 37 percent of the currency in circulation was deposited in banks (YR 1,339 million was deposited out of a currency supply of YR 3,625 million). Thus, 63 percent of the currency was being held in homes, personal strong boxes, or hidden.

Much of the money is being misused, that is, unproductively spent, for example, speculation in land and buildings. Unfinished buildings are an ubiquitous characteristic of Yemeni towns because the owners are delaying construction hoping to negotiate a price with future buyers or tenants or simply waiting until prices rise with the annual inflation of about 30 percent. (The price index in 1973/74 was 154 and rose to 329 by June 1977; this was an annual average growth of 29 percent.)

2.9 The Growth of Imports

Imports have risen rapidly, about ten-fold in six years, as shown below:

Table 2.9

YEMENI IMPORTS
1972/73 - 1977/78

Year	Imports in YR, Millions	Converted to US $, Millions	Increase Over Prior Year
1972/73	411	91	-
1973/74	745	166	82%
1974/75	981	218	31%
1975/76	1,707	379	74%
1976/77	3,035	674	78%
1977/78	6,195	1,377	104%

Source: Central Bank of Yemen, Financial Statistical Bulletin, March, 1978.

ccording to the Yemeni Statistical Yearbook, the number of camels eclined only slightly from the 1972 peak of 117,000 to 110,000 in 976. However, if later data were available, the decline would oubtless be much sharper because the number of half-ton trucks has isen rapidly to displace the camel. In one village, Al Kowlah in urbah Governorate, there were 150 camels in 1975 and only 25 in ate 1978.

2.10 Hasty Importation of Technologies

The remittance phenomenon has brought about a hurried attempt since 1973 to bring in a wide range of technologies from abroad. There has been very little screening for suitability under Yemeni conditions. The judgment of the Yemeni consumer has resulted in a prudent selection of products in some cases (25 KW and above generators for village use, 75 HP tractors for the inter-montane plain and the Tihama), but in the general rush to buy, errors are being made often because the consumer and the importers are ignorant of what is available on world markets (vehicles are not suited for unpaved mountain trails).

Retail prices are being paid that seem unreasonably high; for example: (a) single axle Korean 11 HP tractor with attachments costs YR 28,000 or US $6,222; (b) a pedal-operated sewing machine from Taiwan costs YR 1,000 or US $244; (c) an Electrolux 10 cubic foot kerosene refrigerator from Sweden costs YR 6,000 or US $1,333; (d) a Japanese 3 KW gasoline-powered generator costs US $1,555.

Repair facilities and spare parts are in short supply resulting in idle equipment.

2.11 Types of Technologies Now Being Imported

As mentioned, the imports reflect both good and poor judgment on the part of consumers and the importing agents. A few trucks and passenger cars are suited for the unpaved mountainous roads of Yemen. Some tractors are ideal for the flat plains of the Tihama or in the inter-montane valley north of Thamar, but other tractors are unsuitable because they have the wrong attachments, or plow too deeply or cannot maneuver in small terraced plots or climb unpaved mountain trails.

Home appliances for sale in retail stores appear to be a haphazard collection of equipment from countries of origin producing a low-cost and gaudy-looking product. Bathroom and kitchen equipment to improve sanitation is almost non-existent in retail stores.

Construction equipment (except for that used for large multi-storied buildings in Sanaa, Taiz and Hodeida) is primitive and high cost. Cinder block and cement is carried by teen-agers from the ground to upper floors in housing construction since there are no conveyors.

Manufacturing industry world wide has achieved major advances in technology and has invested in costly programs of R & D much of which could benefit Yemen. The resulting products are often ideally suited to conditions in Yemen, but the consumers in Yemen and the distributors often are unaware of such products.

Japanese "tillers" (single-axle tractors) similar to the American roto-tiller have revolutionized agriculture in southeast Asia, but are not seen in Yemen. The camping boom in the United States has brought about the development of pressure lamps, cookers, cots, sleeping bags, water purifiers, which could be used in Yemen. The Italians have developed tractors with off-center attachments for terraced mountain fields. The Japanese (Komatsu Manufacturing) have developed a crawling mini-dozer of about 20 HP which could probably be used on trails in Yemen's rugged highlands above the 6,000-foot level.

As mentioned, Yemen's imports now exceeding the US $1.0 billion mark annually are growing and have been growing at annual increases of 31 percent to 104 percent since 1972 (see Table 2.9 above). Much of the remittance earnings are being spent for imported technologies that are not suitable for the country, but there are some examples of eminently suitable and fast selling technologies. The Volvo dealership (Elaghil Trading Co.) is introducing the latest small-scale rock-splitting and cutting equipment; the Caterpillar agent (Tehama Trading Co.) maintains three stationary workshops and operates four mobile repair shops for the diesel engines of Caterpillar bulldozers and other road building equipment. Such equipment and "product-support" facilities were unknown in 1973. The Yanmar distributor (Allowaa Elakdar) with the support of its principals in Japan, has introduced compressors, pumps, gen-sets and maintains both stationary and mobile workshops to service the thousands of items of equipment that they have sold in Yemen.

2.12 Domestic Technologies

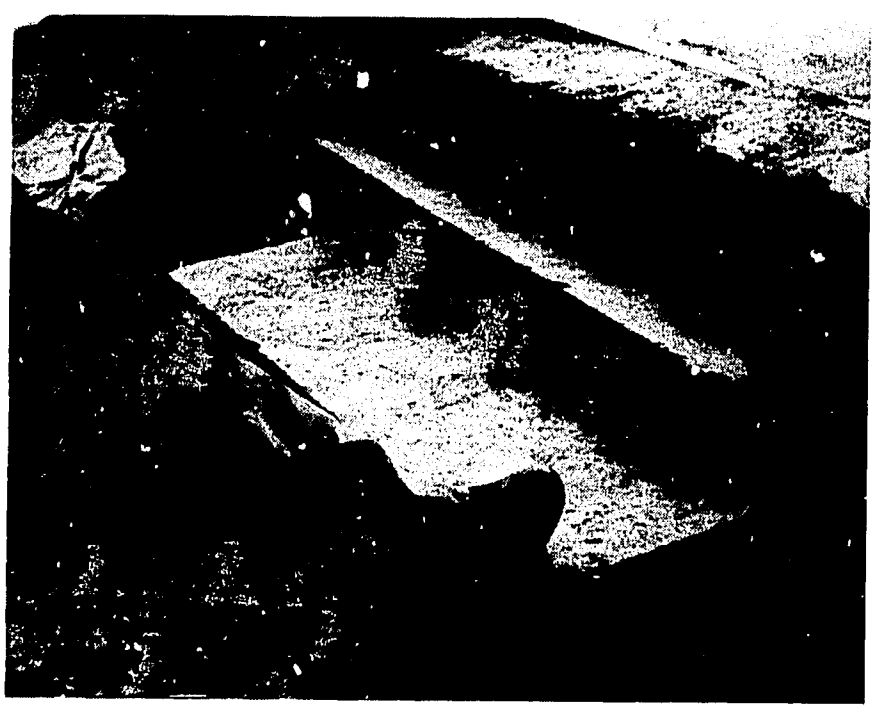
Despite world-wide advances in home architecture and appliances, virtually all Yemeni houses have the traditional old-style virtues and shortcomings. The virtues include rugged stone or mud construction, fire resistance, and thick walls to insulate homes from outside heat and to retain warmth in the winter (temperatures occasionally fall below freezing in the highlands).

Among the shortcomings of Yemeni housing are the almost total absence of sanitary facilities, over-clutter in kitchens, no facilities for the exhaust of smoke from wood fires, uneconomical use of roof space, the absence of running water and roof tanks to allow water supply by gravity.

Home electrification is proceeding rapidly, however, as more and more villages are installing community generators or individual home owners are purchasing small (3 to 5 KW) units for their home fluorescent lighting (20 watts per tube). However, the benefits of electricity in terms of better living are not being fully achieved. This, as with other technologies, is due to the fact that neither consumers nor dealers are aware of the technologies available. Local currency is available and is freely convertible, but is being used for only a few of the technologies that Yemen needs.

This shows typical housing in the mid-lands and highlands. Walls are of stone and masonry construction. Loose stones on roof are in part to provide privacy for roof activities and for defense (that is, stones can be hurled on intruders but almost never are). The roofs of these houses could be used for water catchment during the rainy seasons, July-August and March-May, but rarely are so used. This house, located near Thurba, has TV aerial on roof to receive black and white transmissions from Djibouti and Riyadh. When Yemeni relay station is built in Taiz, reception of Sanaa TV transmissions will be possible.

This shows pre-cast concrete steps introduced by The Netherlands Integrated Rural Development Project, Radat. This reduces costs of steps by 40 percent below the cost of traditional stone steps.



As mentioned, total Yemeni imports are now exceeding an annual level of $1.0 billion. For the year ended June 30, 1978, total Yemeni imports were the equivalent of $1.4 billion. For U.S. readers of this report, it is of interest that during the six-month period ended December 31, 1977, sales of U.S. commodities to Yemen were valued at $4.6 million, or less than one percent of the half-year total. The U.S. performance in earlier time periods was 2.7 percent in 1976/77; 1.3 percent in 1975/76; and 2.2 percent in 1974/75. Most of the Yemeni imports from the U.S. were rice and edible oil products and Caterpillar earth moving machinery. Very few of the imports consisted of equipment that could be classified as appropriate technology.

During the last three years, Japan's share of Yemeni imports has usually been the largest ($91 million in 1976/77); other leading suppliers to Yemen have been Saudi Arabia (transhipments), U.K., Australia, India, West Germany, Singapore, The Netherlands, Italy, Peoples China, and Djibouti.

2.13 Market Trends for Appropriate Technology

For purposes of analysis, we are classifying appropriate technologies under two broad headings as follows:

1. "Off-the-shelf" technologies consist of equipment suitable for Yemen that is already being manufactured chiefly in the industrialized countries or in a few cases in Yemen itself. This category includes such equipment as small-scale tractors and attachments for soil preparation in the terraced highland farms or pumps suitable for lifting water from ground level tanks to roof tanks or kerosene stoves to replace wood stoves, etc.

2. "Domestic" technologies consist of modified equipment currently used or changes in methods of performing tasks or changes in construction methods or building design that are suitable for and usually improve living, working and health conditions.

These two broad categories are in turn subdivided into seven (7) applications as follows:

1. Agriculture
2. Construction
3. Home appliances and home design
4. Health products
5. Manufacturing and repair
6. Transport
7. Energy

2.14 Off-the-Shelf Technologies

The system for recording imports in Yemen was changed for 1976 to a five-digit SITC system from a different four-digit system used for prior years. Within the time limits of this project, an analysis of the trend in imports of specific equipment could not be made. (Such an analysis would be a good indicator of what the Yemeni consumer is buying in the largest volumes; such an analysis would also indicate the growth trends in sales to Yemen of specific kinds of equipment). However, some indication of the market size and growth rates can be seen from the import summaries shown in the Statistical Yearbook (Central Planning Organization). These data do not present a complete picture of imports because some vehicles and equipment are brought in by road from Saudi Arabia and are not reflected in the Customs figures. The broad categories of imports shown in the following table reflect the level of demand and growth in sales of broad groupings of equipment to Yemen.

Table 2.14-A

GROWTH IN VALUE OF IMPORT GROUPS CONSISTING LARGELY OF OFF-THE-SHELF APPROPRIATE TECHNOLOGY
(years as shown in parentheses)

SITC Group	Description	Value (US$000's)	Value (US$000's)	Annual Average Growth Between Years Shown
59	Other chemicals (almost all pesticides)	$ 370 (1972/73)	$ 1,022 (1975/76)	41%
71	Non-electric machinery (90% consists of gasoline, diesel engines for pumps, compressors, generators)	$ 3,968 (1972/73)	$11,166 (1974/75)	70%
72	Electrical machinery	$ 2,398 (1972/73)	$ 6,330 (1974/75)	60%

Source: Statistical Yearbook, 1976/77, Central Planning Office; growth rates calculated by Checchi.

Another indicator of the demand for off-the-shelf technologies used in agriculture can be seen in Table 2.14-B based on a study made by the Central Planning Organization. The explosive growth in tractor imports from 1974 to 1976 began to slow down in 1977. According to the Massey Ferguson and Volvo dealers, the tractor imports slowed down in 1977 and 1978 because of a leveling off of remittances from workmen in Saudi Arabia. This leveling off was attributed to a short-lived Saudi policy of reducing the wages of Yemeni workmen to a level accepted by workers from other areas (Bangladesh, India, Sudan, the Philippines). However, with the discontinuation of this Saudi Arabian policy in the late summer of 1978, tractor imports are expected to surge upward again.

The rapid growth in pesticide imports (see both Tables 2.14-A and B) is attributable to the increase in sales of mechanical sprayers and spare parts and in the growing realization among farmers that aphids, stem borers and blister rust can be readily controlled. (The import classification called "pesticides" includes some fungicides as well.)

Table 2.14-B

IMPORT GROWTH OF SELECTED OFF-THE-SHELF TECHNOLOGIES
USED IN AGRICULTURE
1973 - 1976
(Unites: as stated in column headings)

Calendar Years	Tractors (Units)	Pumps for Irrigated Agriculture (Units)	Pesticides (Metric Tons)
1973	63	3,479	457
1974	63(sic)	3,285	717
1975	238	4,333	1,834
1976 (est.)	1,420	5,916	1,004
(Annual Average Growth)	(280%)	(19%)	(30%)

Source: Statistical Yearbook, 1976/77, Central Planning Organization; growth rates calculated by Checchi.

Appropriate technology equipment is included in one of the SITC code groups used by the Central Planning Office in Yemen. The code group is entitled "Machinery and Transport Equipment." Table 2.14-C below shows that over the three-year period ending June 30, 1978, the Machinery and Transport Equipment group of imports rose very rapidly from the equivalent of $64 million in 1975/76 to $404 million in 1977/78 (year ending June 30, 1978). This was an annual growth rate of 250 percent.

During the same three-year period, the Machinery and Transport Equipment group of imports increased as a percentage of total imports; that is, the share of the group rose in relation to all other groups. In 1975/76, the group share was only 17 percent. Three years later, the share had grown to 29 percent.

These figures, shown in the following table, indicate the strong surge in demand for labor-saving equipment, motor vehicles and motorcycles, road-building equipment, and tractors.

Table 2.14-C

GROWTH OF IMPORTS
INCLUDING MACHINERY AND TRANSPORT EQUIPMENT, SITC GROUP 7
1975/76, 1977/78
(Units: millions of U.S. $ and percent;
years are 12 months ending June 30)

Group	Description	1975/76	1977/78	Annual Avg. Growth
0	Food and live animals	$164 (43%)	$ 343 (24%)	44%
1	Beverages, tobacco	10 (3%)	30 (2%)	72%
2	Raw materials	2 (1%)	7 (1%)	90%
3	Fuels & lubricants	18 (5%)	38 (3%)	45%
4	Fats	2 (1%)	10 (1%)	225%
5	Chemicals	18 (5%)	78 (6%)	
6	Mfgd.goods classified by materials	69 (17%)	342 (24%)	220%
7	Machinery and Transport Equipment	64 (17%)	404 (29%)	250%
8	Miscellaneous	81 (8%)	119 (9%)	80%
9	Goods not elsewhere classified	- -	8 (1%)	-
	TOTAL	$380 (100%)	$1,377 (100%)	90%

2.15 Types of Technologies Now Used

In preparation for this report, we made two field trips. The first was a brief visit to Taiz and return trip to acquaint ourselves with the rugged mountainous terrain and the agricultural practices of the highlands and the inter-montane plain.

The second field trip was to (1) Hodeida, (2) Mochka, (c) Taiz, (4) Turbah, (5) Taiz again, and (6) return to Sanaa. Short field trips were taken to the German agricultural improvement project at Al Boun (Wadi Seer) near Amrhan and to the village of Beni Husheysh, a prosperous farming area endowed with an adequate water supply from tube wells and benefitting from the leadership of Mr. Nasser al-Moafa, a former senior official of the Ministry of Agriculture.

In all these trips, we noted the types and suitability of technology and assessed its appropriateness for the Yemeni economic and social envirnment. We found some technologies that were highly appropriate and some that were egregiously inappropriate.

The solid stone masonry of the highland housing was excellent. General home sanitation, waste disposal and kitchens were deplorable.

Four-wheel drive passenger-cargo vehicles (Toyota Land Cruisers) were appropriate, but the 20-ton refrigerated vans snaking up the hairpin mountain roads were questionable. In agriculture, the popularity of deep plowing, over 30 cm., with 85 HP tractors, did not seem appropriate, whereas the 5 HP Danish roto-tiller seemed promisingly appropriate for the terraced agriculture of the highlands.

Technologies for the home were generally lacking, but a few promising items were found, such as kerosene and butane stoves to replace the costly and unpleasant wood-fired stoves. The following tabulation shows that wood is 5.68 times as expensive as kerosene.

Table 2.15

COMPARISON ON BTU BASIS OF THE COST OF KEROSENE, WOOD AND CHARCOAL IN YEMEN 1978

Type of Fuel	Retail Price in Towns	BTU Yield Per Unit	Cost per BTU	Index No.
Kerosene	$0.45/liter	34,286/liter	$0.0000131	100
Firewood air-dried[a/]	$0.42/kg.	6,050/kg.	$0.0000694[b/]	529
Charcoal	$2.22/kg.	29,828/kg.	$0.0000744	568

a/ Average BTU yield of air dried (a) resinous wood of 4,800 BTU and (b) non-resinous wood of 6,300 BTU.

b/ Wood is 5.3 times as expensive as kerosene in terms of BTU yield, that is, 694/131 = 5.3.

Source: Retail prices based on field trips in Yemen; BTU for each fuel based on engineering handbooks.

This is the traditional type of stove for baking Arab flat bread (khubz). The interior of the stove consists of an oil drum surrounded by a ceramic case for insulation. Firewood is inserted and open flames bake the dough pressed against the inner surface of the oil drum. Partly obscuring the hand in this picture is a tongue of flame from firewood below; women complain about the danger of burning their hands and about the wood smoke that fills their kitchen when this type of stove is used.

These are kerosene burners made in People's China. The retail price is equivalent to $5.55 to $7.78. Yemeni households are beginning to use these stoves despite the local dislike of kerosene odors. This is because of the high cost of firewood and charcoal. On a BTU basis, firewood costs 5.29 times as much as kerosene and charcoal costs 5.68 times as much as kerosene.

In the field of health products, we found pharmacies well stocked with vitamins, ethical and proprietary drugs but available without prescription; baby formula food and bottles and nipples were widely sold, but sterilization equipment was not.

Obstetrical and circumcision equipment in use has probably remained unchanged for thousands of years.

Equipment for the milling of sorghum, wheat and barley is beginning to appear. Treshers are only being tested by the British-Yemen Agricultural Engineering Project in Taiz, and threshing and winnowing by hand probably accounts for almost all the grain being produced.

The handling of marine products is one of the most primitive processes we saw. No provision is made for sanitation and preservation at the coastal fish markets, and only one wholesaler (at Hodeida) had a cold storage plant to hold marine products until refrigerated vans could carry the material to the major urban markets in Taiz and Sanaa.

Fishing technology was also primitive, that is, lines only are used, to catch Red Sea fish about five to nine kilometers offshore. The building of wooden fishing boats is accomplished with manual tools only (bit and brace, hand saws) despite the overhead power lines within a few yards of the boat yard. A boat with a carrying capacity of about 200 kg. costs YR 120,000, or the equivalent of $27,000.

In the energy field, Yemen is coping quite well with the problem of rural electrification. The most popular generators on sale are in the 3 to 5 KW range, capable of lighting a single home and operating a refrigerator or even a one-burner electric stove. Some villages with strong leadership have pooled their resources to purchase larger generators in the 25 to 60 KW range. Although the cost per KWH is high, the fact remains that electricity is far cheaper than manpower at today's wages.

These and other observations on off-the-shelf technologies are listed in Exhibit 2.15, starting on the next page. Examples of health technologies are omitted since they are covered in Chapter 3, Recommended Selection of Technologies.

EXHIBIT 2.15

Note: This exhibit describes the characteristics of a sample of technologies now in use in (a) agriculture, (b) construction, (c) homes, (d) manufacturing and repair, (e) transportation and (f) energy. Health products are omitted since they are discussed in Chapter 3, "Recommended Selection of Technologies".

Each of the technologies described below has been given a preliminary rating for appropriateness. The Rating 'A' means most appropriate, 'B' less so, and 'C' means inappropriate. The criteria used for rating are described in Chapter 3 (Section 3.4).

AGRICULTURE

Description	Origin	Retail Price (Converted to U.S. dollars)	Remarks and Suitability for Rural Use Rating: A, B or C
5 HP "Texas" brand roto-tiller, with mould-board plow, cultivator, dozer blade for forming bunds, and 300 kg. trailer; engine is Briggs and Stratton; weight is 20 kg. Roto-tiller is hand-held and has single axle.	Denmark (Pionar is manufacturer)	$1,889	Sales have just started but should be Rated 'A' for terrace agriculture if HP is sufficient.
Cultivator, single axle with one-ton tractor trailer, plow, cultivator and leveller. 12 HP gasoline engine.	Korea (Dae Dong is mfgr.)	$6,222	Underpowered for dense alluvial soils. Too heavy for terrace agriculture. Rated 'C'.
Leveler, attachment for tractor, to break clods on small (9,000 sq. ft.) plots. Does work in 1/6 time as bullock.	United Kingdon (SKH is manufacturer)	$400 (est.)	Application limited to inter-montane and tihama soils but Rating is 'A'.
Power-driven potato digger as attachment for tractor.	United Kingdom (Manufacturer is A. Newlands & Sons, Linlithgow, Scotland)	Not available	Being tested by Yemen-British Ag. Eng. Project in Taiz.
Seeder attachment for dropping seeds behind tractor-drawn cultivator. Used for soghum, wheat, barley, millet planting.	France (Nodet is manufacturer)	$300 (est.)	British Ag. Eng. Project in Taiz is testing for modification. Should be Rated 'A'.
Sorghum stalk chopper with folding legs (to allow 15 inch clearance); powered by three HP Clinton gasoline engines. Chopped stalks are used for feed.	United Kingdom (Ransom Hunt is mfgr.)	Not available	Given 5 HP engine, this would rate 'A' because chopping stalks tedious female job and, usually, animal feed is in short supply.
Sorghum thresher; does work of three men; about 5 HP gasoline engine	United Kingdom (OSAW is manufacturer)	Not available	Modifications to improve head recovery and chaff removal. Being suggested by Yemen-British Ag. Eng. Project.
Tractor, 47 HP, with attachments (mould-board plow, tine cultivator, disc harrow, ridger) and power take-off; two-wheel drive.	United Kingdom (Massey Ferguson is manufacturer. Model is "MF 135").	Not available	Suitable for about 2/3 of farm land in Yemen Arab Republic. Rated 'A'. (Four-wheel drive not suitable.)

EXHIBIT 2.15 (continued)

Description	Origin	Retail Price (Converted to U.S. dollars)	Remarks and Suitability for Rural Use Rating: A, B or C
Vertical pumps for irrigation, can pump 20 M^3 to 60 M^3 of water per hour from 150 to 220 M. deep, depending on water supply.	Sweden, West Germany, Italy, Spain, Cyprus (later is "Nemitas" brand imported by Jumaan Trading.)	Depending on capacity, $300 to $5,000	Irrigated farming increasing rapidly and pumps in higher capacity range needed. Suitability is 'A'.
	CONSTRUCTION		
Cutter to make stones for house construction.	Italy, Belgium, Germany	Depending on capacity, $5,000 to $20,000	Testing is needed to prove economics. (Dutch project in Rada believes capacity must be fully utilized to be economical.)
Stone drill and splitter with gasoline powered 10 HP motor, for drilling, implanting wedge and forcing special steel wedge into hole. Can split 4-ton rock in four passes in two minutes or less.	Sweden (Pionar is manufacturer)	About $500	Suitability 'A+' since reduces splitting time to 1/20 of manual splitting.
	HOME APPLIANCES OR UTENSILS		
Electric or kerosene-fueled, 10 cubic foot refrigerator for home use.	Sweden (Electrolux is mfgr.)	$1,333	Too large and initial cost is too high, but suitable for rural areas without power. Rated 'C'. (Smaller refrigerators available, but villagers like 10 cubic feet for prestige.)
Electric cooking oven, 19" diameter, 1000 watt-connected load.	Lebanon	$67	Requires too much power for individual house or village generators. Will not cook flat bread. Rated 'C'.
Kerosene, single burner stove, made of welded brass sheet and brass tubing.	Japan ("Original" brand) Spain ("PAT" brand)	$8.50	Cannot cook Arab flat bread (Khubz) no pressurization; open flame gives odor, but fuel cost is 1/5 of wood. Rated 'B'.
Kerosene stove with adjustable burner and lift-off cylindrical oven for making Arab flat bread, plus 15 liter roof tank for gravity feed of kerosene to burner. Entire unit made of welded angle irons, galvanized sheet-steel and galvanized water pipe.	Made in Yemen, 1 km. north of Turbah	$900 for burner, plus oven, plus roof tank	Suitability i ···

EXHIBIT 2.15 (continued)

Description	Origin	Retail Price (Converted to U.S. dollars)	Remarks and Suitability for Rural Use Rating: A, B or C
Plastic (dense polyethylene), red-colored, trash container with lid, 18" diameter, 24" high.	Hong Kong and Lebanon	$8	May have cadmium-based pigmentation which is toxic when released. Low cost containers urgently needed for sanitation and this is Rated 'A' except for possible cadmium pigmentation.
Plastic (PVC) moulded shoes for boys without ventilation holes.	Yemen	$2	Very low-cost foot wear, but unhealthy for feet. Rated 'C'.
Pump for ground to roof use, 2 HP gasoline engine.	India (make is "Ideal")	$89	Rated 'B' because of low engine power. (This is a "best seller" in Yemen.)
Refrigerator, 10 cubic feet, requires 300 watts power.	Sweden (Electrolux is mfgr.)	$356	Suitable for homes with city power but not for rural because too large and because local power at night only. Rated 'C'.
Teflon frying pan, about 10" diameter.	France	$7	Not used much in village cooking. Rated 'C'.
Washing machine, agitator type, 12 lb. capacity.	U.S. (General Cold is mfgr.)	$800	Requires too much power and water for rural use. Rated 'C'.
	MANUFACTURING, PROCESSING AND REPAIR		
Hand saw for cutting boards used by commerical carpentry shop.	U.S. (Stanley is mfgr.)	$9	Top quality hand saw; Rated 'C' because portable power saw would cut labor to 1/50th.
Manual bit and brace for drilling holes in teak planks during fishing boat construction. Takes 50 seconds to drill hole, plus waiting time.	People's Republic of China	$7	Rated 'C' because power drill would cut labor time to 1/20th - 1/30th.
Compressor for tire inflation, 5 HP gasoline engine.	U.S. (Briggs & Stratton product)	$1,555	Suitable for small-scale auto servicing shops, rural areas without power. Rated 'A'.
Electric powered, deep freeze, about 60 cubic feet, for retailers dealing in frozen imported chicken; requires about 1,000 watts.	Sweden (Electrolux is mfgr.)	$800 (without generator)	Suitability is 'A' for rural communities needing storage for individual families or for holding inventory of frozen products.

EXHIBIT 2.15 (continued)

Description	Origin	Retail Price (Converted to U.S. dollars)	Remarks and Suitability for Rural Use Rating: A, B or C
50 HP compressor, ammonia-based, plus receiver and condenser, powered by diesel engine for 150 cubic meter cold storage for holding marine products in fishing ports, such as Hodeida, Mocha, for delivery to wholesalers.	Japan (Maekawa is mfgr.)	Without engine, about $15,000	Ammonia is best refrigerant. (Freon freezers are too high stress, high RPM, subject to leakage and more frequent breakdowns.) This product is suitable for fishing ports. Rated 'A'.
Mobile workship, 120 HP diesel enginer, 4-wheel drive (originally developed by Volvo for Swedish Army); can repair most frequent engine failures, i.e., (a) nozzle cleaning, (b) filter change, (c) fuel line, condensation, (d) injection pump adjustment.	Sweden	About $25,000	Now used exclusively by Volvo, but similar equipment needed by other distributors and workshops. Suitability is "A'. Farmers won't come to stationary workshop 10 to 100 km away.
Sorghum, barley, or wheat mill about 30 kg. per hour capacity for village use; powered by diesel engine or tractor power take off.	Denmark (Europe-mill brand)	About $1,300	Suitable for rural community use. Rated 'A'.
	TRANSPORTATION		
Land Cruiser, short wheel base, 4-wheel drive, accommodates six persons plus cargo in roof rack. Engine has about 75 HP.	Japan (Toyota is most popular)	$11,000	Like U.S. Jeep, is ideal for rough terrain; can be used for cargo or passengers. Rated 'A'. Note: The long-wheel base Land Cruiser is not suitable for rough terrain.
Motocylces, 50 to 100 cc. gasoline engines.	Japan (Yamaha, Suzuki, HOnda)	$1,400	Ideal because of low stress, low RPM, slow idle and light enough to lift over pot holes or ridges; low fuel consumption.
	ENERGY		
5-kw. generator set with 10.5 HP gasoline engine.	Japan (Yanmar is mfgr.)	$4,000	Good for welding in small body shop or metal product fabrication. Suitability is 'A' but has limited application.
Same, but equipped with diesel engine.	Japan (Yanmar is mfgr.)	$2,222	Frequency of repairs outweighs fact that diesel fuel costs only 52% of gasoline. Rated 'C'.
15 kw generator set for 5 to 8 houses, 23 HP Yanmar diesel engine.	Japan	About $7,000	Some villages cannot agree on community power, but groups of individual houses often agree. About 20% of houses in rural Yemen have power. Rated 'A'.
Generator, capacity 2-1/2 - 3 kw, enough to electrify two houses, gasoline 5 HP engine.	Japan (Robin & Kawasaki are manufacturers)	$1,667	Gasoline generators of this size are best sellers in villages where there is no community power. Rating is 'A'.

EXHIBIT 2.15 (continued)

Description	Origin	Retail Price (Converted to U.S. dollars)	Remarks and Suitability for Rural Use Rating: A, B or C
Wind mill and pump.	U.S. (Fairbanks Morse windmill and Colombiana pump)	Not available	Rated 'A' if wind fairly constant and over 10 knots, but spare parts reserve is essential.

The village of Al Kowla in Thamar Governorate, 20 km east of Thamar. The older houses are sited on the hill. After three years of negotiation among the inhabitants, the village was electrified by a Fiat generator brought in from Saudi Arabia at a cost of $32,000. The 55 KW generator electrifies all 150 houses in the village (of about 2,500 population), operates a pump drawing water from a 20 meter deep well, runs four shorghum mills, lights streets, a mosque and a school. There is a surplus of generating capacity since only one-third of the potential is now in use for above purposes. Consideration is being given to extending power lines to nearby villages.

2.16 Reasons for an Appropriate Technology Program

Current and foreseeable trends suggest a continuation of improvements in terms of per capita GNP. However, there are compelling reasons why the present influx of revenue should be subjected to some measure of guidance to avoid waste, to assure future economic viability, and to assure an orderly transition from archaic living conditions to modern standards. These reasons are described below.

A. Most countries seeking development endeavor to guide the influx of technology by various means, such as the allocation of foreign exchange, the judicious selection of manufacturing licensing agreements between local and foreign companies, consumer education or an outright ban on the use of technologies and machinery deemed wasteful of national resources or socially harmful. No such guidance and screening of imported technologies and machinery is taking place in Yemen and measures to force the inflow of technology along one line or another would probably prove to be administratively unworkable--unworkable because of (1) the inability of the Government to monitor the use of assets widely dispersed among the people, (2) the political unrest that would result from the imposition of controls, (3) the freedom with which currencies are now exchanged, and (4) the difficulty of controlling imports of many items that would tend to flow even more freely across borders than at present if centralized controls were erected. (Vehicles are one of the few controllable imported items because a truck or car driven into Yemen from abroad must be licensed to operate on the streets and conventional imports through the port of Hodeida or "unconventional" imports driven in by individual owners from the north are subject to the same overall licensing restrictions.)

B. Given this situation and the continued probability of inward remittances, a program is needed to inform the consumer and the local sales representatives of foreign manufacturers about the suitability or unsuitability of given types of equipment. This would include a program to systematically inform the Yemeni public about the availability of machinery and technologies that are already available abroad but which are not reaching the Yemeni consumer.

The last several decades of R & D in the industrialized countries has brought out valuable technologies that could be but are not being used in Yemen. For example, the Japanese "tiller" or single-axle, two-wheel tractor has almost completely replaced draft animals in Asia and is credited with being a major factor in the raising of farm productivity. Ingenious equipment manufactured in the United States is virtually unknown in Yemen, such as small-scale applications of the gasoline engine (Briggs & Stratton, Kohler or Clinton). The Italian development of off-set tractor attachments is not known. These off-set attachments permit the tractor to exert its weight near the center of a mountain terrace while the plow or harrow does its

work near the outer extremities of the farm plot. Technologies in India, Pakistan, and the Philippines are being developed (in part through the Rockefeller and Ford Foundations and AID-sponsored projects); knowledge of these technologies has not penetrated the Yemeni consuming public because the manufacturers' representatives and the public tend to buy machinery they know about and not necessarily machinery that would be most suitable for the Yemeni conditions.

C. There are already several bi-lateral and multi-lateral programs at work in Yemen to introduce appropriate technology. Striking directly at problems in agriculture is the Yemen-British Agricultural Engineering Program at Taiz. A few UN programs have also been started in the past on a minor scale (FAO and UNIDO). However, these programs have a narrow geographic and product focus; in a country as diverse climatically and topographically as Yemen, such programs have only a limited impact. The Yemen-British group in Taiz is still testing a sorghum thresher after two years' effort; this is no criticism of the British effort, but rather an indicator of the thoroughness of the testing, the difficulties of conducting field trials, and the engineering of modifications to render the original equipment suitable for Yemeni conditions. A program to select promising technologies, test them, publicize and introduce them is therefore needed.

D. The projections presented earlier of rising GNP, fueled by remittances, are largely projections of past trends. The future however, could unfold in quite a different pattern from the past, perhaps leaving the Yemeni economy quite defenseless. For example, the strong appetite for imported goods could bring about a growth of imports (already rising at about 70 percent annually) that gradually exceeds the growth in remittances. Wages in Yemen are rising and may soon reach levels equal to those prevailing in Saudi Arabia. This would reduce incentives for Yemeni to work abroad.

In short, the outflow of Yemeni assets could begin to equal or exceed the inflow, leading to a need for import controls accompanied by the political problems of trying to police the now open frontier.

A switch from surplus to deficit would quickly necessitate an emphasis on capital productivity, that is, an emphasis on preventive maintenance and careful handling of machinery--in contrast to the throw-away attitude that prevails today. Cars and trucks, driven over mountain trails or on off-the-road flat lands, tend to last only two to three years. Expensive tractors and construction equipment lies idle much of the time (UNIDO estimates that about one-third of Yemen's tractor fleet is inoperative; this is because the suppliers' representatives, with a few exceptions, have seriously deficient programs of product support and because the owners or operators have no training nor even an awareness of the need for preventive maintenance).

Under today's conditions of affluence, Yemen can afford to let its citizenry indulge in the fun of importing today and scrapping tomorrow. Given any kind of national economic reverse, the economy would be fragile indeed and the presence of substantial numbers of imported vehicles, tractors, generators, and pumps would quickly become a liability.

The tradition of preventive maintenance takes decades to develop through an upgrading of attitudes and skills on the part of consumers and machinery importers. With a few exceptions, there are far too few efforts made on the part of the machinery sales people to deliver repair services and parts to the hinterland where some 80 percent of the populace resides. These changes in skills, attitudes, and performance will not take place automatically but should be generated through a systematic program of education and persuasion.

E. Yemen's importing community consists of about ten leading firms representing Japanese, British, German, Danish, Swedish, French, and a few U.S. firms (see Annex A). The overseas connections of the importing companies are limited. (A substantial amount of Caterpillar construction equipment and a handfull of Briggs & Stratton engines were seen during our field trips. Several importers asked us to put them in touch with U.S. companies and product lines.)

Because of their limited contacts and because only the proven "best sellers" are imported, much of the world's appropriate technology is not known to the importers. The Yemeni public thus remains deprived of the benefits of R & D that has been going on for decades in the industrialized world. A program to identify, test, and introduce items of equipment that are especially suited to Yemeni conditions is needed to protect the consumer, to offset today's labor shortages, and to prepare the nation for economic reverses should they reoccur in the future.

F. Health, sanitation and the deplorably inefficient and unpleasant home life for women are discussed in Annex B. Living conditions in the Twentieth Century which are not very different from those described in the Old Testament have a part to play in the high infant mortality rate (about 50 percent) and the high incidence of adult diseases. These conditions, especially with the return of migrants from the West and rapidly spreading influence of television, will not be tolerated as time goes by.

G. The labor shortage is serious in Yemen as brought out by the following estimates developed by the USAID Mission in Sanaa:

POPULATION, LABOR FORCE, MALE LABOR FORCE
AND EMIGRANTS WORKING ABROAD
1978

Total population	5,460,000
Persons over 15 years of age	2,730,000
Males over 15 years of age	1,365,000
Males working abroad	600,000
Percentage of males over 15 remaining in Yemen	56% (765,000/1,365,000)
Percentage of males over 15 working abroad	44% (600,000/1,365,000)

In an age of high emigration, productivity of males should be high and rising which is not the case. Women should be entering the labor force which they are increasingly doing for farm work, but this trend is not fast enough because women feel compelled to meet their home obligations first. This means that work at home should be made as efficient as possible, but work efficiency in the home is exceedingly low.

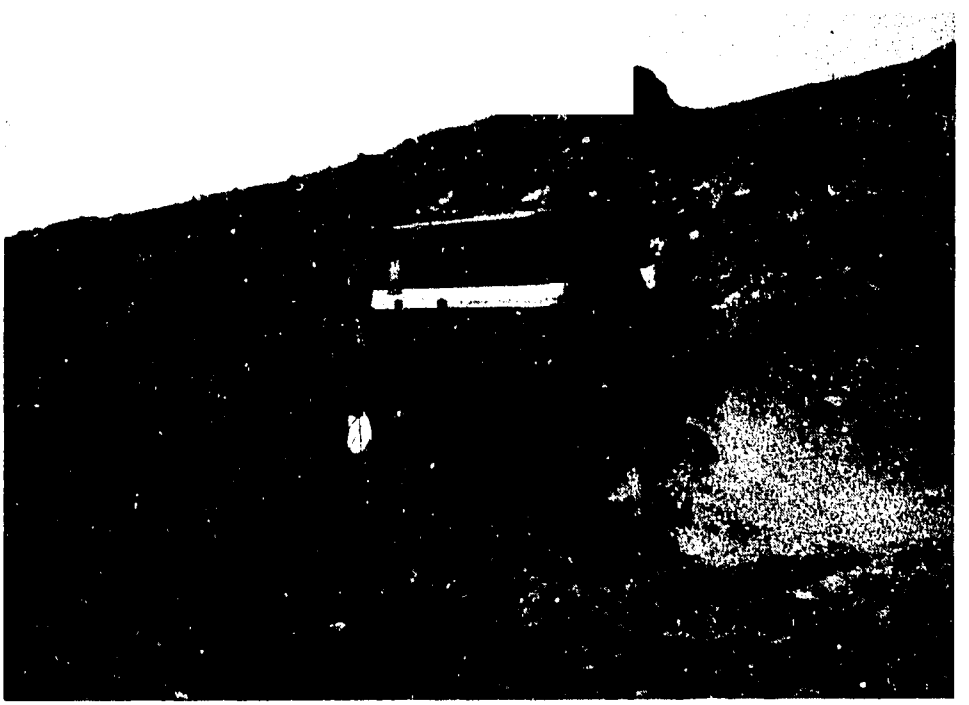
H. A final reason for introducing a program of appropriate technology is the likelihood of acceptance. Both women and men express an eagerness to know about new technologies and ways to improve the output of exixting machinery.

The importing community, motivated as it must be by profit considerations, is also trying to do better. Some importers are doing much better than the majority; companies like Tehama Trading, Elaghil, and the Yanmar dealership are trying to select machinery that is best suited to Yemeni conditions and are doing their best to bring repair services to the farmer rather than waiting for the farmer to come to them. These firms have mobile repair vans that can repair the kinds of breakdowns most frequently encountered (i.e., condensation in fuel lines, fuel injection pump adjustments, nozzle cleaning, changing of filters for oil and fuel, replacement of pump gaskets, and generator coil rewinding.)

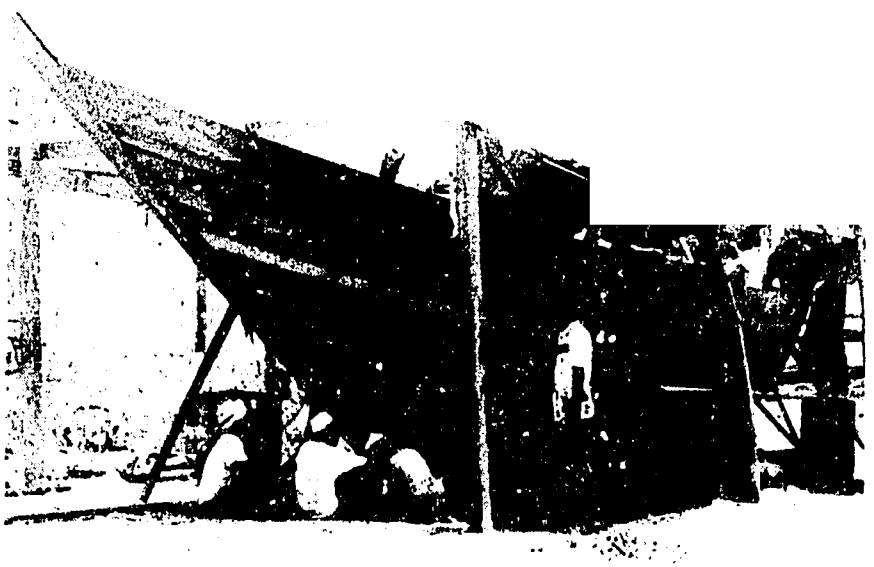
The surge in machinery imports began in 1974 and 1975. This means that the vehicle and tractor fleets, pumps and generators, for example, are beginning to wear out more rapidly; 1978 and 1979 should see an acceleration of breakdowns, suggesting that an early program of appropriate technology would be very timely.

This picture, taken from a moving car on an unpaved mountain road, shows a mobile diesel engine repair workshop. This vehicle, used by the local Volvo dealer, was originally designed for mountain transport for the Swedish Army. The equipment in this vehicle can repair the most commonly incurred breakdowns, namely (1) moisture condensation in fuel lines, (2) nozzle cleaning for fuel injection equipment (f.i.e.), (3) f.i.e. adjustment, and (4) fuel and oil filter replacement.

This mobile workshop goes to the farmer, even in the remote highlands, rather than having the farmer bring his equipment to the workshop in a town.



This fishing boat under construction on the beach near Hodeida will cost the customer $27,000 (YR 120,000). Four carpenters take 90 days to build this craft entirely with hand tools despite the availability of a power source about 50 meters distant. When in operation, these vessels will be equipped with a Johnson or Evinrude outboard motor and will carry about 200-300 kg. of fish caught by lines in the Red Sea.



Hand tools made in People's China used to construct fishing boats. Power line about 50 meters distant would have cut hole-drilling time to about one-twentieth. Lower picture shows adze for trimming plank ends.

2.17 Alternative Strategies for Introducing Appropriate Technologies

The basic strategy for introducing appropriate technology to Yemen consists of five steps, but there are numerous possible variations in the strategy, depending on the type of technology (the word "technology" in this discussion means machinery or methods usable principally in agriculture, home and health improvements, and manufacture and repair).

The five basic steps are listed below:

Step 1 - Conduct a literature search to identify technologies suitable for arid, fuel-short, mountainous countries (such a search would involve the publications of organizations already engaged in the development of appropriate technologies such as A. T. International, Washington, D.C.; McGill University, Montreal; Georgia Institute of Technology, Atlanta; Intermediate Technology Group, London; and others listed in Annex F.)

Step 2 - Conduct a search of trade literature of companies in industrialized countries engaged in the production of equipment and machinery initially in three categories: agriculture, home and health, repairs and manufacturing (see Chapter 3, Sections 3.6 and 3.7 later in this report).

Step 3 - Import into Yemen samples of equipment or obtain specifications on equipment or housing deemed potentially suitable for Yemen. Where samples for testing are not available, every effort would be made to manufacture local prototypes (see Annex C, Manufacturing Plants in the Yemen Arab Republic).

Step 4 - Equipment or other technologies would be field tested in Yemen in cooperation with other donor or Yemeni groups, such as the Peace Corps, the British Volunteers, the Yemeni-British Agricultural Engineering Project (Taiz), the Federal Republic of Germany Project (Al Boun), and later on, if an Engineering or Agricultural Department is established, the University of Sanaa.

Importers of machinery should be asked to test equipment; the top importers and their product lines are listed in Annex A to this report.

Technologies for the home and health would be tested with the help of such organizations as Save the Children Foundation (Mahweit), the Catholic Relief Services, the Women's Affairs Department of the Ministry of Education, and others.

Step 5 - Once technologies are identified and found appropriate for Yemen, every effort would be made to assure their distribution, taking advantage of the availability of the radio and TV, the importers (Annex A), other donor agencies, and, where suitable, the agencies of the Government.

Under Step 5, the assistance of specific companies, Government agencies, and donor groups should be sought, depending on the nature of the technology concerned. In all the applications, the help of manufacturers representatives can be critical. Exhibit 2.17-A lists these representatives and Annex A shows their product lines and their estimated annual sales volumes. Adban Trading Company handles a diversified product line including tractors, pumps, and vehicles. Tehama Trading Company is the leading tractor sales company with a 40 percent share of the Yemeni market; Elaghil Trading Company has the second largest share of the tractor market, 30 percent, and also handles construction equipment including machinery for road construction, rock cutting, and small-scale equipment for terrace soil preparation.

All the companies listed in Annex A are eager to try out new products and are especially interested in U.S. products. Except for Caterpillar earth-moving equipment and a very few Briggs & Stratton gasoline engines and Westinghouse refrigerators, we found almost no market penetration in Yemen by the U.S. manufacturers. Yemeni imports have reached an annual level of U.S. $1.4 billion (year ended June 30, 1978) as mentioned.

There will be occasions when the help of the media should be enlisted. This involves Radio Sanaa and the Sanaa TV station with its relay stations in Sadaa, 140 km north of Sanaa, and in Yarim, 90 km to the south. Two newspapers, Al Thawr in Sanaa and Al Gumhurya in Taiz, have an estimated 40,000 readers and a combined paid circulation of about 15,000. The radio and TV offer greater promise as a means of disseminating information on technologies because of the limited newspaper circulation and the illiteracy of about 80 percent of the population. Radio ownership, thanks to the introduction of transistorized receivers, is probably close to 100 percent of the households. TV ownership is spreading rapidly and plans have been made to introduce color TV in Yemen by 1979. Color TV transmissions are already reaching Yemen from Saudi Arabia.

Government support of tariff and tax changes could be a desirable tactic for encouraging the introduction of technologies that are found to be especially important. The present tariff and tax structure is as follows (after Table 2.17-A):

EXHIBIT 2.17-A

TEN LEADING YEMENI IMPORTERS OF
APPROPRIATE TECHNOLOGY
RANKED BY ESTIMATED SALES VOLUMES IN 1977

Rank	Name of Importer	Estimated 1977 Sales Volume YR/Millions (U.S. $ Equivalent/Millions)
1.	Adban Trading Co.	YR 280 (U.S. $62)
2.	Tehama Trading Co.	YR 230 (U.S. $51)
3.	Elaghil Trading Co.	YR 220 (U.S. $49)
4.	Awataarni G. Trading and Agriculture Development Co.	YR 200 (U.S. $40)
5.	Jumaan Trading and Industrial Corp.	YR 80 (U.S. $18)
6.	Al Mohdaj	YR 50 (U.S. $11)
7.	Ali Jobran Elansi	YR 10 (U.S. $ 2)
8.	Al Sonidar	YR 10 (U.S. $ 2)
9.	Faisal Alamri Trading Center	YR 8 (U.S. $ 2)
10.	Allowaa Elarda	YR 5 (U.S. $ 1)

Source: Annex A.
U.S. dollar conversions are rounded to nearest million.

Customs Duties:

Tractors and attachments	10% on c.i.f. value
Pumps	5% on c.i.f. value
Generators	15% on c.i.f. value
Home appliances	20% to 30% on c.i.f. value

Defense Tax:

Imposed on all imported products	7% on c.i.f. value

Confederation of Yemeni Development Association (CYDA) Tax:	2% on c.i.f. value

From interviews, we found that the Government is reluctant to raise the customs duties and the tax structure, but duties and taxes could be lowered by decree. Increases, however, would involve legislative action which would doubtless risk the emergence of opposition from importing companies and consumers.

The introduction of off-the-shelf technologies (i.e., machinery already in existence) will be more easily accomplished than the introduction of what we are calling the "domestic" technologies. The latter involve changes in the construction of homes, changes in kitchens and home appliances, better home sanitation, non-traditional bathrooms, better nutrition, new styles in cooking, and even exposure to sunlight to avoid rickets. Most of these changes involve women, and the subservient and isolated position of Yemeni women means that changes in domestic technologies will be slow to come. The deplorable conditions within the Yemeni household--virtually unchanged since Biblical times--exist side-by-side and in contrast with the rapid modernization that is taking place in other sectors of Yemeni life. Therefore, domestic technologies must command priority attention in the project described in Chapter 5 of this report.

Throughout the project suggested in Chapter 5 would be an effort to upgrade skills, taking advantage of such institutions as the Sanaa University and the National Institute of Public Administration (NIPA). Efforts would also be made to strengthen the vocational training capabilities of the workshops of the machinery sales companies such as those representing Yanmar Diesel, Massey Ferguson, Caterpillar, Volvo and the vehicle dealerships.

Exhibit 2.17-B which follows shows the range of organizations with which cooperative action should be sought for introducing technologies. In most cases, the support and cooperation of the manufacturers' representatives would be needed. In the domestic technologies, the support of the Peace Corps, the Netherlands projects and USAID's own rural development projects will be critical.

EXHIBIT 2.17-B

ORGANIZATIONS IN YEMEN THAT CAN HELP IN INTRODUCING APPROPRIATE TECHNOLOGIES

1. Agriculture

   a. Confederation of Yemeni Development Association (CYDA)

   b. Local Development Associations (LDA's)

   c. Ministry of Agriculture

   d. Agricultural Credit Bank

   e. Bilateral donor programs (Federal Republic of Germany project at Amran; Dutch projects at Rada, Rawdah and Dhamar; British Agricultural Engineering Project at Taiz; USAID Poultry (019), USAID Small Water Project (044), Local Resources (045), Sorghum and Millet Improvement (030); Tropical and Subtropical Fruit Development (024); U.S. Peace Corps; British Volunteers.

   f. FAO National Agricultural Research Center, Taiz; FAO Training Institute for Extension Officers at Ibb; World Bank Fisheries project executed by FAO; World Bank Southern Uplands Project (BUR DEP); World Bank Tihama Development Authority at Hodeida

   g. Representatives of manufacturers of agricultural equipment, pumps, pesticides, fungicides and herbicides such as Elaghil (Volvo and Pionar), Adban (Yanmar and Pionar), Adban (Yanmar pumps), Tehama Trading (Massey Furguson tractors) See Annex A)

2. Construction

   a. CYDA and LDA's

   b. Representatives of manufacturers of construction equipment and tools (See Annex A)

   c. U.S. Peace Corps

3. Home Appliances

   a. Ministry of Education, Womens Affairs Dept.

   b. Representatives of manufacturers (See Annex A)

   c. Health Manpower Institute

   d. U.S. Peace Corps

   e. Dutch Integrated Rural Development Project, Rada

Exhibit 2.17-B (Continued)

4. Health Products

   a. Ministries of Health and Social Services

   b. Representatives of manufacturers (See Annex A)

   c. French project (Compagnie de Dévelopment International et de Recherche at Mokha

   d. Health Manpower Institute

   e. U.S. Peace Corps

   f. Dutch Integrated Rural Development Project

5. Manufacturing and Repair

   a. Ministry of Economy, Department of Industry and Ministry of Supply

   b. UNIDO in Vienna, Austria

   c. Representatiges of manufacturers of diesel and gasoline engines, generator sets, vehicles and motorcycles, and grain mills (See Annex A)

   d. British Agricultural Engineering Project in Taiz

   e. Industrial Bank of Yemen

   f. Federation of Yemen Industries

6. Transportation

   a. Ministry of Transport and Communication

   b. Representatives of manufacturers of vehicles including tractor trailers (See Annex A)

7. Energy

   a. Yemen General Electricity Corporation (YGEC)

   b. Representatives of manufacturers of generator sets (See Annex A)

2.18 Alternative Strategies for Introducing Appropriate Technologies for Homes and Health

The rural inhabitants of Yemen show an eagerness to adopt new technologies for their homes and for their villages. However, there are factors which are preventing the households and communities from moving ahead faster in the adoption of technologies. These factors include:

(a) A lack of knowledge as to which technologies are the best, for example, a butane stove vs. a kerosene stove; or an electric pump to raise water to the roof tank or a diesel pump; a 5 KW home generator or a 3 KW generator.

(b) Most of the decisions affecting the home require the approval of males. Some males with experience abroad are quick to want changes at home, but others do not appreciate the importance of home improvements.

(c) The lack of mobility on the part of women hinders their freedom of access to the larger urban markets and retail stores where new equipment can be seen and bought.

(d) In the case of community improvements, such as solid waste disposal or a village-wide electrification system or pumps for a central water supply, the village residents must agree among themselves on the type of technology and the cost, and they must decide who pays how much for what. These decisions sometimes involve protracted discussions to reach a consensus. (One village we visited, Al Kowla in Dhamar Governorate, with 3,000 inhabitants, took four years to reach a decision to purchase a 55 KW Fiat generator sufficient to electrify all 200 houses in the village, to run a pump for the cistern, and to operate a deep-freeze for the commercial storage of meat and dressed poultry.)

In general, all but the poorest families have money, as mentioned, but factors such as the above are delaying the introduction of technologies that could improve the home and community environment.

Even now, some modern household equipment can be found in rural homes and farms such as blenders, kerosene stoves, or fans. The typical channel for introducing such equipment has been through migrants returning from Saudi Arabia, the U.S. or elsewhere where such equipment is readily available. Village women soon become aware of newly introduced household equipment, fabrics, or pharmaceuticals through their network of afternoon social gatherings (usually qat parties). Many of these

women will request their absent husbands to send or bring similar items or send the money and permission for the item to be purchased in-country for the wife. Annex B to this report describes the practice of having a surrogate for the absent husband, such as a brother or other male relative who will be instructed to do any purchasing for the home.

Among the various alternatives for introducing appropriate technologies to rural people in Yemen, the following are being used successfully by the Catholic Relief Services in Hodeida, the Save the Children Foundation in Mahweit, and other expatriate groups concerned with home and health improvements:

1. Consult individual housewives, especially older persons with leadership potential, as to their choices for new or appropriate technologies.

2. Work through the existing power structure in rural communities, usually the sheikh or the chairman of the LDA.

3. Work through the Ministry of Information in Sanaa, the radio stations and the one television station to publicize technologies such as new equipment, new nutritional concepts, better types of home construction, kitchen ventilation, or home sanitation procedures.

Often there is a traditional and formal power structure existing side-by-side with an informal but more effective power structure in villages. It is important in each case to identify both. It is unwise to completely bypass representatives of the formal structure, who may be able to sabotage the introduction of changes. It is better to consult such representatives, usually a sheikh or LDA chairman, so that they give at least nominal consent to the introduction of new technologies and thereby maintain their image of leadership in the village. In such a situation, a traditional leader knowing he cannot hold back progress, may be persuaded to cooperate to the extent that conservative, potential opponents of a technology may be persuaded to support, or at least not interfere with changes. In a sample survey of development attempts in Yemen, David Gow reports that a progressive sheikh was murdered by members of his own family who felt that his increasing popularity with more progressive members of the community would threaten their future claim to the sheikhdom. (See Annex E, Bibliography, item 20.)

Possible new leaders in a community may be found among the educated younger men, school teachers, successful merchants, or returned migrants. Any of these may be members of or heads of community organizations, such as the LDA or a less formal alternative organization of leadership groups within a community.

In the case of innovations related strictly to women, there is a possibility, but only a very slight one, that a women's organization exists through which to work in introducing new technologies.

In the great majority of cases where no women's group exists, initial direct contact with women would probably be ill-advised and counter-productive. New technologies should be presented to a male leader or group of men, and their cooperation sought in organizing a group of women to approach. Even if the informal forum of the women's afternoon party should be chosen as the best place to approach women, this should be done through the men.

Another reason for introducing technologies for the women's sphere through the men is that women need permission of husband, father, or brother (or a suitable surrogate) for any major purchase or non-traditional activity. Indeed, it is well in the case of any major change, such as a change in nutrition, not only to approach the women through the men, but to educate the men in the desirability for a change. In some cases, men may even pressure their wives to adopt a new method, but in any event, no woman would be able to maintain changes in family eating habits that did not meet with her husband's approval.

In Chapters 5 and 6 of this report, we are recommending that one of the long-term (three-year) staff members be a woman trained in health education and home economics. Such a person would probably find it useful to make the acquaintance of the leading males in rural villages. This has been done successfully by Ms. Judith Obermeyer (Save the Children Foundation), Sister Joe-Ellyn (Catholic Relief Services), Cynthia Myntti (associated with the Ford Foundation and USAID), and Sheila Carapico (Social Science Researcher with USAID). These expatriate women have found that an initial contact with the village sheikh, for example, often results in an invitation to meet with the sheikh's wife. This contact then leads to others because the village women are usually fascinated with the possibility of learning about non-traditional ways of home management, food preparation, as well as about medicines and home equipment that are new to them.

The use of two media, radio and TV, offers promise as a means of introducing new technologies to rural communities. As mentioned, the low cost of transistor radios has increased radio ownership to almost all the households in Yemen. TV ownership is much lower because the single channel in Sanaa cannot be received in all parts of the country until new relay stations are installed. However, the schedule for building the relay stations suggests that by 1980, all of Yemen will have access to the Sanaa transmissions.

The Yemeni press and magazines are not suitable media for the introduction of new home and health technologies because almost 100 percent of the women are illiterate. (See Annex B.)

CHAPTER 3

RECOMMENDED SELECTION OF TECHNOLOGIES

3.1 Factors Considered in Formulating Criteria

In preparing criteria for selecting technologies, we have considere the following five factors as points of departure (3.1.1 through 3.1.5):

3.1.1 The First Five Year Plan

This document is an expression of Government policy regarding economic and social development. Many aspects of the Plan are relevant to appropriate technology, but the following, quoted from the Plan, are policies to which appropriate technology can contribute:

> "Concentration on increasing productivity;"
>
> "Concentration on food production;"
>
> "Concentration on integrated rural development;"
>
> "Raising the standard of living of all citizens;" and
>
> "Giving women the opportunity to enter the labor force."

The Plan also proposes that development objectives can be achieved more rapidly by the:

> "Utilization of various economic incentives for the development of the productive sectors, such as bank loans, import and export licenses, custom duties, taxes and others."

3.1.2 Capital Productivity

The YAR now enjoys an inward flow of remittances, discussed in Chapter 2 above. As mentioned, the possibility exists that the growing appetite for imports could, in the future, exceed the availability of foreign exchange. This has already happened in Nigeria where oil revenues are now insufficient to meet demands for imported consumer and capital goods. Also, as Yemeni wages reach levels comparable with those in Saudi Arabia, the present abundance of foreign exchange could be replaced by shortages. At that stage, high productivity of capital (meaning better maintenance), improved technical skills and greater financial self-sufficiency will become critically important.

3.1.3 Overall Objectives of the Appropriate Technology Project

The selection criteria have been formulated, keeping in mind the following suggested objectives for an appropriate technology project.

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(1) Accelerate balanced modernization in rural areas by encouraging increased investment in appropriate production technologies.

(2) Encourage the use of technology which increases the productivity of men and women either in their present occupation or in new occupations.

(3) Encourage the use of technology which conserves limited physical resources such as wood, farm land, or water supply.

(4) Encourage the use of technology that can give a high return on capital. This means encouraging the use of machinery that can be easily maintained.

(5) Encourage the use of technology which can reduce social inequities.

3.1.4 Characteristics of the Yemeni Economy and Culture Pertinent to the Objectives

The Yemen Arab Republic has special characteristics which make it an especially fertile field for the introduction appropriate technology. These characteristics, considered in formulating the criteria, include:

(a) The Yemeni people have long-established traits of entrepreneurship, of accepting innovation and of hard work.

(b) The Yemeni worker has a high degree of spatial and occupational mobility, men accept new work abroad, women now tend to assume the work of men and have even broken with tradition to accept jobs in industry and commerce. (Women work in the Chinese-managed textile plant in Sanaa and in virtually all banks.)

(c) Foreign exchange is available for investment in equipment and productive activities. (See Chapter 2 for remittances from abroad.)

(d) Investments made in productive activities are not always appropriate and are far exceeded by speculation or investments in consumer goods.

(e) Wage costs in rural areas, for both the skilled and unskilled, have inflated rapidly, reflecting labor shortages including a shortage of skills essential for the maintenance of equipment.

(f) The current deficit between exports and imports is being met by invisibles (i.e., remittances) but this may be a transitory phenomenon as wages within and outside Yemen tend to equalize and as imports rise by more than 70 percent annually.

(g) Recently there has been a growth of decentralized rural development institutions, including the LDA's.

(h) Financial services in rural areas are inadequate.

(i) Also inadequate is the government structure and staffing in rural areas for the provision of technical services.

(j) Experience is lacking in the distribution and maintenance of the technologies required for rural development. The practices of preventive maintenance, operator training, and product support are neglected except by a few representatives of equipment manufacturers.

3.1.5 Related On-Going Projects

An appropriate technology project could benefit from the programs of several donor agencies and private industry organizations.

As listed in Exhibit 2.17 earlier in Chapter 2, the potential contributing organizations include the British, Dutch and German projects in agriculture and road construction, the U.S. Peace Corps and the various AID projects concerned with rural development, poultry and water supply. The help of private industry (namely, the importers) can also be enlisted to introduce technologies new to Yemen and to help in upgrading vocational skills. (See Annex A for list of importers, product lines, and estimated sales volumes.)

3.2 Suggested Criteria for Technology Appropriate to Rural Yemen

We are suggesting that technologies be evaluated in terms of the extent they achieve the following objectives.

3.2.1 Accelerate Rural Modernization

Technologies appropriate to accelerated growth should meet felt needs and serve to shift rural spending into productive channels. Shifts in investment patterns can be anticipated and, over time, can be measured. The felt need and the investment shift must be accompanied by the effective use of the technology if rural growth is to accelerate. A high level of capacity utilization provides a measure of appropriateness. For example, it is easy to note the load factor of a village power plant or the number of hours of use for a tractor.

3.2.2 Improved Productivity of Men and Women

Given the high cost of labor described in Chapter 2, technologies that do not increase human productivity should be questioned. (A test often applied is to measure the increased value added resulting from a new technology. The incremental value added should approximate 50 percent of the wages paid for labor.)

3.2.3 Productivity of Resources

Market forces in Yemen appear to be operating more effectively for the selection of technology to raise worker productivity than to raise resource productivity. It is possible, for example, that the accelerated drilling and pumping of irrigation water is wasteful of water. Machine pumping, as compared to animal power, is highly productive--the use may not be. Water is less mobile than workers and temporary surpluses of water tend to be used unproductively.

Large tractors, while certainly leading to worker productivity, may not be adding significantly to the productivity of land or of water.

While it has not been possible to apply productivity norms to scarce physical resources it should be possible in the future. For example, it is possible to measure:

- the value added per hectare of land through the introduction of new seeds, herbicides, insecticides;

- the value added for each additional 1,000 liters of irrigation water pumped, saved or recovered; and

- the value added to agriculture or to transport per liter of diesel fuel used in various types of prime movers.

3.2.4 Return on Capital

We have gained the impression that most investments in processing or power generation being made in rural areas are profitable. However, the overall return on capital is low, largely because machinery is not maintained. Also, too many investors' remittances are spent without any reserves for maintenance or replacement. To prepare for the eventuality that Yemen's foreign exchange position could worsen, a high return on investment in equipment is needed.

3.2.5 Reducing Social Inequities

Technologies tend to be more appropriate to the reduction of social inequity if the investment required is small. A small tractor may be appropriate to the needs of more farmers than a large one. The design and promotion of small-scale poultry operations is more likely to improve the economic status of poor farmers than if only large-scale poultry companies were to be encouraged. However, technologies requiring a large "lump" investment can also reach the poor through the LDAs, or village associations. Thus, the use to which the technology is put is what determines its appropriateness. Implied in the social equity criterion is a conflict with the concept that GDP should be maximized.

Rather, it is important that the income of all households be increased. Economic analysis, for example, may favor large poultry farms and social analysis may favor small. Recent evidence from other countries indicates that the social equity approach very soon begins to maximize GDP as well.

3.2.6 Contribution to Home and Health

Technologies would be sought that can contribute to better sanitation, better utilization of space especially for water catchment, better grain storage, easier cooking and kitchen management, avoidance of wood, charcoal and dung as household fuels, and the simplification of household tasks.

3.2.7 Simplicity

The ease with which a technology can be obtained, operated or maintained also determines its appropriateness. The low cost of plastic pipe for village water supplies, for example, is more than offset by the ease with which steel pipe can be installed. Technologies which have long been in use in other LDCs and require minimum adaptation, spare parts and maintenance are to be preferred. A rugged design can more than compensate for a higher first cost. Diesel engineers, for example, are to be preferred for heavy duty machines over gasoline engines, and electric motors preferred over diesel engines where maintenance is a problem.

3.2.8 Minimum Linkages

For many important development activities, the technology--that is the hardware--is a small part of the package of inputs required. The new hardware may require supplementary hardware, a variety of technical services and even new institutions before it can become effective. For example, high speed compressors are usually not appropriate for LDCs.

The results of our field trips in Yemen and a study of the literature have led to the following conclusions regarding program areas, candidate technologies and technologies to be given a priority under the recommended follow-up program in Chapter 5.

3.3 Seven Possible Areas That Could be Covered

The seven possible program areas recommended and a brief justification for each follow:

(1) Agriculture

Farming is a dominant employer in Yemen (80 percent) and makes the largest contribution to the GDP (43 percent in 1976/77). Productivity increases in agriculture are essential to reduce dependency on imported food, to relieve pressure on the labor supply and to release workers for other occupations.

Terraces like these have been used for thousands of years. About 30 percent of Yemen's arable land is terraced (about 50 percent is in the inter-montane valleys and 20 percent in the narrow coastal strip known as the Tihama).

The walls of these terraced plots are beginning to break down owing to the shortage of labor.

(2) Construction

Next to agriculture, construction may soon be the major employer and it is important that high labor productivity be attained. The construction industry can apply technology to conserve scarce materials and energy supplies while building a stock of capital in the form of houses, farm structures, irrigation systems, roads, etc.

(3) Home

The household environment is important to the quality of life and health. Labor saving technology must be introduced to release women for agricultural and other occupations. While Yemen's economy is making strides toward modernization, the households, with few exceptions, are wasteful of woman-power, are unsanitary, are equipped with primitive kitchens and bathrooms, and waste valuable space, especially for water catchment on roofs.

(4) Health

The incidence of disease, child mortality, and health maintenance are among the worst in the world. Infant mortality, exclusive of still births, is about 50 percent.

(5) Manufacturing and Repairs

The potential for manufacturing industry to accelerate rural development is currently low. Manufacturing in Yemen contributed only six percent of GDP in 1976/77 and tends to produce consumer goods (the cement and PVC plants are exceptions. See Annex A for list of plants.) Repair services, on the other hand, are likely to see rapid expansion in rural areas and are essential for the maintenance of new equipment.

(6) Transport

The modernization of the rural areas requires fully adequate transport systems--a sector given the highest priority in the First Five Year Plan. Transport of raw materials, goods and people is technology-dependent and can be wasteful of capital, labor and energy. Most vehicles must be designed for off-the-road performance.

(7) Energy

The relative scarcity of traditional sources of energy, the rising cost of imported oil, the popularity of rural electrification dictate a careful examination of all potential energy alternatives such as wind, solar and biogas.

3.4 Program Concentration

In Chapter 5, later in this report, a project is suggested to introduce appropriate technology into Yemen. To make such a project manageable, we believe it would be desirable to concentrate on a few of the above seven areas. Therefore, we are suggesting that initial efforts be focussed on the introduction of technologies appropriate in three areas only, as follows:

A. Agricultural production and marketing (i.e., haulage from farm to market).

B. Home and health improvements.

C. Agricultural product processing and the repair of equipment used in rural areas.

3.5 Candidate Technologies

Candidate technologies under the program areas have been identified by applying the criteria listed in Section 3.2 above. Candidate technologies listed below that fall within the three priority areas, A, B and C, cited above, are followed by a letter designator (A, B, or C) to denote the category in which they can be classified.

Agricultural Production

(1) Hand tools including hoes, spades, axes, pitch forks, and rakes. (A)

(2) We are proposing that no attempt be made to introduce and test new animal-drawn implements. We recognize the conventional wisdom that improved animal-drawn implements should be used before resorting to machine power--as was the strategy of Japan some 40 years ago. In Yemen, however, tractors are becoming available and appropriate attachments are being tested and selected. Very little adaptive research appears necessary for tractors, but some for trailers. By contrast, any improvement in animal-drawn equipment would be arrived at only by a long and expensive process, and would not be productive when farm mechanization is moving ahead rapidly.

(3) Tractors, small in size--5 to 25 HP--for terraces and single-axle walking tractors of about 10 HP, most having a power take-off shaft. These tractors should be powered to climb steep trails and some should be separable to permit transport by hand or donkey-back. (The "Texas" brand rototiller made in Denmark has a separable 20 kg. engine to facilitate lifting.) (A)

(4) Low capacity mills for poultry and animal feed and for sorghum, barley and wheat. (C)

(5) Pumps for irrigation and for potable water for human and animal use. (A and B)

(6) Seed cleaners and other equipment for seed multiplication and distribution. (A)

(7) Sprayers, dusters and other herbicide and pesticide application devices--generally back-packed and hand operated. (A)

(8) Seed drills operated with cultivators. (A)

(9) Post hole diggers for contract use. (A)

(10) Land levelers, tractor drawn. (A)

(11) Cultivators. (A)

(12) Fertilizer where water supply suffices for solubility. (A)

(13) Veterinary equipment and supplies. (A)

(14) Larger fishing boats than are now used, i.e., "sambuks" with low RMP, low stress, light weight, inboard diesel engines.

Construction

(1) Stone cutting and shaping equipment (but thoroughly tested for economics at different levels of utilization).

(2) Improved lime and gypsum kilns and blends of whitewash for interior walls.

(3) Carpentry shops to make furniture and construction components.

(4) Prefabricated concrete products and other concrete products

- floor and wall tiles to improve sanitation
- bathroom fixtures
- roofing tile and concrete slab roofs with water catchments
- concrete or asbestos-cement pipe (A)
- stronger cinder block
- pre-cast stair cases to reduce stone cutting costs (as the Dutch project is doing in Rada)

This is a wedge-shaped stone used in building the walls of houses. A stone cutter chips the rough stone to form a wedge and then smoothes the outer surface. Such a stone cutter can earn substantial wages depending on hours worked (if he works 300 days per year, 6 hours per day, and cuts 6 stones per hour, he can earn the equivalent of $31,200 per year).

(5) Powered elevators and portable conveyor belts (as in Japan) for construction of residential housing.

(6) Prefabricated windows and doors (already being produced in Sanaa).

(7) Playgrounds for children in medium and large towns.

Home

(1) Improved systems for water conveyance from ground to roof level including methods for the gravity flow of water to kitchens and bathrooms. (B)

(2) Better utilization and surfacing of roof space including methods of collecting water during rain storms for upper level storage. (B)

(3) Improved stoves including solar cookers and the elimination, where possible, of the use of costly wood and charcoal. (B)

(4) Exhaust fans for the removal of smoke from kitchens. (B)

(5) Solar heating of hot water. (B)

(6) Improved collection of human waste to avoid street level contamination. (B)

Health

(1) Water purification and filtering in homes. (B)

(2) Sterilization and standardization of village equipment for obstetrical and circumcision use. (B)

(3) Introduction of dung substitutes for the sealing of grain storage pits and cooking fuel. (B)

Manufacture, Repair and Agricultural Processing

(1) Cement; expansion of domestic production should be given a priority.

(2) Trailers for farm tractors and motorcycles and bodies for busses and trucks. (A)

(3) Local village mills for sorghum, barley and wheat. (C)

(4) Non-food agricultural product processing such as mixed feeds for livestock and poultry and chopped vegetable waste for composting. (C)

(5) Diesel engine repair and overhauling by mobile workshops as Volvo and Caterpillar are doing. There are four standard repairs needed to keep Yemeni diesel engines operating: (a) condensation in fuel lines, (b) nozzle cleaning, (c) oil and fuel filter cartridge change, and (d) injection pump adjustment. (A)

(6) Electric motor/generator repair and rewinding. (B)

(7) Lead storage battery rebuilding. (A)

(8) Standardized vehicle repair tools and package workshops in small towns such as those offered by the SNAPON Tool Company of the United States. (A)

(9) Tire repair and recapping. (A)

(10) Consumer electronic equipment repair and package workshop tools and test instruments. If the radio and TV are used for publicizing new technologies, such repair facilities will become important. (A, B, C)

(11) Threshers with at least a 5 HP tractor, electric motor or gasoline engine drive. (C)

(12) Winnowers. (C)

(13) Machine harvesters and small-scale "combines" such as those manufactured by Kubota of Osaka. (A)

(14) Chaff cutters. (C)

(15) Corn shellers. (C)

(16) Farm level grain storage. (C)

(17) Sesame and cotton seed crushing and edible oil refining. (C)

(18) Sorghum stalk choppers for the preparation of feed. (C)

Transport

(1) Bicycles and bicycle trailers (as were used in Taiwan, Japan and Korea for unpaved roads before 1950). (A)

(2) Mopeds and trailers for rough terrain. (A

(3) Motorcycle-drawn two-wheel trailers. (A)

(4) Trailers for tractors, 2-5 tons capacity. (A)

Hand-forged farm plow tip, weeders, and furrow trimmer. Plow tip costs $44.44 (YR 200). Weeders and trimmer range from $4.44 (YR 20) to $6.67 (YR 30) each. Plows typically need sharpening after a few days use and may last two plantings before breaking.

Automobiles for private use, plus taxis for public use, are found in rural areas and are driven on roads for which they are unsuited (a waste of capital). Similarly, small (usually 1/2 ton) trucks are replacing the camel and dominate goods and passenger transport. Short-wheel base, smaller, jeep-like vehicles with four-wheel drive would be more appropriate.

On the main highways, lighter vehicles could be used including village-to-market motorcycle drawn trailers. (A)

For both off-and on-highway use, the potential of farm tractor/trailer combinations should be explored. They were used along the "silk" road into China during the 1940s and the technology has since been vastly improved. (A)

Energy

Design technology for village electric systems. (A and C)

The traditional energy sources in the YAR have been wood, charcoal and animal dung and some human excrement. Petroleum products, all imported, now are the dominant energy source. Increasingly, petroleum products are being converted into electric power. Total gasoline imports jumped from 82,000 tons in 1970 to 200,000 tons in 1976.

Village associations, LDAs and local entrepreneurs have been installing diesel powered village electric systems at a rapid rate covering some 20 percent of the highland villages. These systems are wasteful of energy and operate at low load factors. Nevertheless, they satisfy a felt need and are evidently profitable judging by their proliferation. Most provide power only for lighting, radio and TV, but others are serving grain mills, pumps, household appliances, welding machines, and compressors for tire repair.

The following table (adapting data from rural India) illustrates the economies attainable from greater generator capacity and higher load factors.

Installed Capacity of Village Electric Plant	Load Factor			
	30%	40%	50%	60%
	(cost in U.S. dollars adjusted to 1978 prices)			
25 kw	.20	.16	.12	.10
50 kw	.13	.11	.09	.08
100 kw	.11	.09	.08	.07
200 kw	.08	.07	.06	.05

The above table indicates power cost reductions that are possible in the YAR. At present, Sanaa power costs $0.13/kw hour at a 52 percent load factor. Village power costs are in the range of $0.22 to $0.44/kw hour. (Most YAR village plants are now below 25 kw capacity. However, one village we visited had two competing 15 kw Yanmar generators and one had a 55 kw Fiat generator.)

Even the existing electric power costs are low relative to the cost of human or animal muscle power. The Yemeni worker on a sustained basis produces about 1/20 hp, for example, in the hand-milling of grain. In short bursts, he can generate one-tenth hp. If the market cost of unskilled labor is taken as YR 7.00 per hour, the power cost is equivalent to electric power at about YR 180 per kwh. By assuming that the opportunity cost to the worker amounts only to the cost of the incremental food he requires, labor costs are still higher than present village electric power rates. Animal power, because of lower food costs, is a fraction of human costs--but still quite expensive.

Even should there be an unexpected reduction in the market value of labor, the drive toward the mechanization of agriculture will continue because of greater efficiency and higher yields.

Agricultural Waste Materials and Biogas (B and C)

Brush wood, dung, charcoal, and sorghum stalks are used as cooking fuel. It is probable that these materials are more valuable as animal feed, for compost as plant food, a mulch, or as materials to reduce soil erosion. Further study may suggest the use of kerosene exclusively (as in Mexico) as an aid to reforestation and soil fertility.

The biogas generator used in China, India, Pakistan and Korea has the advantage of returning waste to the soil while supplying methane. The most viable units require at least village level operations. In the YAR, biogas might be managed along with village water and electric power systems. A research and testing program would be required such as that now planned in Mahweit by the AID-sponsored rural development project.

Wind Power (C)

The windmill can play a modest and specialized role in the YAR. Importers should be encouraged to demonstrate commercial windmills of the traditional U. S. farm type. They are still being manufactured in the United States by a number of firms.

Yemen is not ready for the manufacture of windmills in shops or on the farm (the VITA publicized Arusha windmill is not considered appropriate for Yemen because of a lack of local skills.) The testing of large wind machines would probably be inadvisable at present. (Under development in the United States and Europe, for example, is the 15 kw Grumman generator.)

Solar Energy (B and C)

Solar energy has long been used in Yemen for grain drying and will be used in the future through the introduction of grains giving doubled yields per hectare.

Solar energy devices for space and water heating are well tested and ready for use. However, there is a question as to their practicality and market appeal in Yemen. Importers should be encouraged to test stoves and package-type water heaters for both household and commercial use.

Solar-powered pumps are being tested in Senegal but, to date, the technology is not ready for application.

The photovoltaic, or solar cell, is not yet economical for rural use. In fact, the U. S. National Academy of Sciences, in writing about all innovative energy devices, recently reported:

> "We are unlikely to see any really dramatic change in the relative importance of conventional and unconventional sources in the next 10 - 15 years." (Energy for Rural Development, NAS, Washington, D. C. 1976.)

3.6 Working With Importers to Identify and Test Candidate Technologies

In Chapter 5, later in this report, an appropriate technology project for Yemen is described. Much of the work of the technician staff associated with the program will consist of a continuing dialogue with importers who are the local representatives of machinery suppliers (see Annex A for list). Many of the importers have developed sophisticated distribution channels for equipment which they import. Collectively, the importers offer the most efficient channel for distribution of technologies new to Yemen and also a potentially valuable channel for the conduct of field tests.

Some of the most effective importers are (1) Adban Trading Company, representing Yanmar Diesel of Japan; Chrysler Corporation of the United States; and Steko Pump Company of Cyprus; (2) Tehama Trading Company, representing Massey Ferguson of the United Kingdom; Caterpillar Company of the United States; and Dynapak of Sweden; (3) Elaghil Trading Company, representing Volvo of Sweden; Westinghouse of the United States and Electrolux of Sweden; (4) Awataari G. Trading and Agriculture Development Company, representing Fendt Tractors of West Germany; Bucyrus Rock Drills of the United States; and Robson Agricultural Equipment of the United Kingdom; (5) Jumaan Trading Corporation, representing Robin Diesel of Japan, and Nemitas of Cyprus (20 to 80 hp vertical pumps).

There are types of equipment already being manufactured which would appear promising for use in Yemen but are not now available. Some typical examples are (a) Italian-made attachments for small tractors that may be useable in Yemeni terrace agriculture; (b) British-made machinery for chopping sorghum stalks; (c) Japanese-made combines which produce small-size bales of fodder material that can be more easily transported on mountain trails than conventionally-sized bales (the dimensions of Japanese bales are about 50 cm x 40 cm x 40 cm); (d) low horsepower threshers and winnowers are reportedly made in India; (e) applications for low horsepower gasoline engines made in the United States.

Equipment such as the above will require field testing. The most efficient method of testing will be to engage the help of the leading importers. If the importers are enthusiastic about the prospects for sales of a given item, they may be willing to import prototypes at their own expense and cooperate with reliable farmers already known to them in conducting field trials.

The continuing dialogue with the importers will also result in the identification of candidate technologies that may not be apparent at the outset of the program. Therefore, open channels of communication with the importers and--in turn, through them--with suppliers overseas can be an effective method for bringing new technologies to Yemen.

A pair of Yemeni bullocks, usually small in stature, yields 0.5 HP to 1.0 HP, according to Dr. D. N. Kherdekar's study for UNIDO of February 20, 1978. A pair of donkeys or one camel generates almost the same horsepower (one man generates 0.1 HP).

The Massey-Ferguson Model No. 185 has 85 HP and is probably now the best selling tractor in Yemen. Some analysts believe the switch from bullocks to the 85 HP tractor is an over-reaction to the urge for modernization.

3.7 Candidate Technologies for Home and Health

3.7.1 Technologies for Homes

Much of the money remitted to Yemen by emigrant workmen is spent on improving the home or in building a new home. One of the major social changes occurring as the result of the new wealth is the trend for young married couples to move from their traditional home with the husband's family to a small home of their own. In most rural areas, homes are now being equipped with kerosene pressure lamps (or fluorescent tube lights if electricity is available), a small kerosene stove, sewing machines of many types, and a number of thermoses.

At the same time, most villages still depend on traditional water systems that often provide insufficient water and are completely lacking in hygiene. Most rural homes still depend on traditional kitchens, bathing and toilet facilities.

In many cases, a small modification of existing facilities--while communities await modernization--could greatly improve living conditions in terms of better sanitation and food preparation, thus adding greatly to the quality of life. In the examples of desirable technologies that follow, the intent is to start with what the people have now, rather than to wait for the provision of facilities necessary for the use of modern, imported equipment. In addition to providing for immediate improvements, the suggested technologies and equipment have been designed to make maximum use of local natural resources thereby reducing imports and saving energy. For this reason, it is likely that some of the following suggested equipment and technologies will serve on a long-time rather than an interim basis. As traditional energy sources become depleted--especially wood and charcoal--energy-saving equipment may become more critical.

The following technologies for improving home situations refer to the most common house type of the Yemeni inter-montane plains and highlands, the multi-storied stone and mud-brick house typically having the following features:

(a) Kitchens under the roof.

(b) One or more bathrooms consisting of a hole with a drop for excrement leading to a small room, a pit, or the open ground alongside the house, plus a second hole through which urine is channeled to the ground, a pail from which water is dipped by means of a tin can for either washing or flushing purposes and, in turn, channeled to the urine drain.

(c) Several sitting/sleeping rooms, the largest and highest (mafraj) serving for the afternoon social qat session.

(d) An animal stable and grain storage facilities on the ground floor; space for food storage is sometimes provided by caves in nearby rocks, in pits under the house, or on upper floors of the house.

Most households occupying the above types of houses consist of an extended patrilineal family with more than one woman as well as some girls to share the housework. While the presence of several women undoubtedly eases the burden on the individual Yemeni housewife, many women today express the desire for improvement, particularly in the kitchen where the traditional fuels, i.e., wood, dung and sorghum stalks, create thick clouds of irritating smoke. The smoke lingers at eye level despite the presence of several exhaust holes in the roof. Women also complain that they often burn their arms while using the traditional bread oven (tannur), which is heated by a central open flame fueled by wood and/or dung. Dough for making the pancake-shaped bread (khubz) is pressed against the wall of the oven for baking.

3.7.1.1 Solar Cooker

To eliminate the problems of smoke and burns, to reduce the cost of fuel, to prepare for the day when wood will no longer be available, and to eliminate animal dung as a source of food contamination, the first household improvement we would suggest is to move the traditional stove with its deepwell bread oven to the roof, and adapt it for solar cooking. At the same time, its versatility could be increased.

Climatically and culturally, Yemen would appear to be an ideal place for the solar cooker. There are about 2,800 hours of sunshine in the Tihama and over 3,000 hours in the highlands, providing sunshine almost all year. Even in the two rainy seasons, rain comes in short bursts. Since the major meal is eaten at noon, cooking occurs at a time of full sunshine. This meal pattern is in accord with the Yemeni practice of social qat chewing in the afternoon. Chewing qat reduces appetite so people want to be well fed before they chew.

An argument cited against replacing the traditional oven fuel is that the charcoal residue of the cooking fire is used later to heat the mada'ah or water pipes (called hooka in India) and incense burners that are features of qat sessions. Where this poses a constraint to acceptance of solar cooking, alternative sources of charcoal, such as small packets of charcoal briquettes, could be made available--locally produced or imported--which would cost far less and consume much less wood than the traditional stove fuel.

Figure 1 on the next page shows a possible design for the solar stove/oven. Included are adaptations to expand its functions to include roasting, baking or steaming in the oven well, and top-of-the-stove cooking and grilling on the flange surfaces. Trials would have to be made to determine the proper width and thickness of the cast aluminum flanges. Trials should be held either in Yemen or, if elsewhere, under atmospheric and solar conditions similar to those of Yemen.

Another traditional Yemeni bread consists of several thin, round layers of dough, about 12 inches in diameter which are fried in a metal bowl to resemble the Indian chapati or the Mexican tortilla. The traditional metal bowl-shaped pan could be placed on the hot surface of the aluminum flange of the solar oven/stove, or the flange could be designed with a depression to serve as a built-in pan for cooking this bread. The flat surface of the flange could also be used for top-of-the-stove cooking of vegetables, sauces, etc.

An engineer and manufacturer in Turba, Mr. A. J. A. Abdul Wahab, has adapted the traditional flat bread-making oven for kerosene and sells this stove for YR 4,000. Ms. Judith Obermeyer, of Save the Children Foundation in Mahwheet, suggests that a household biogas generator could also be used to fuel the tannur.

Biogas ovens are operating successfully under Peace Corps sponsorship in Nepal and under many local sponsors in India and Pakistan.

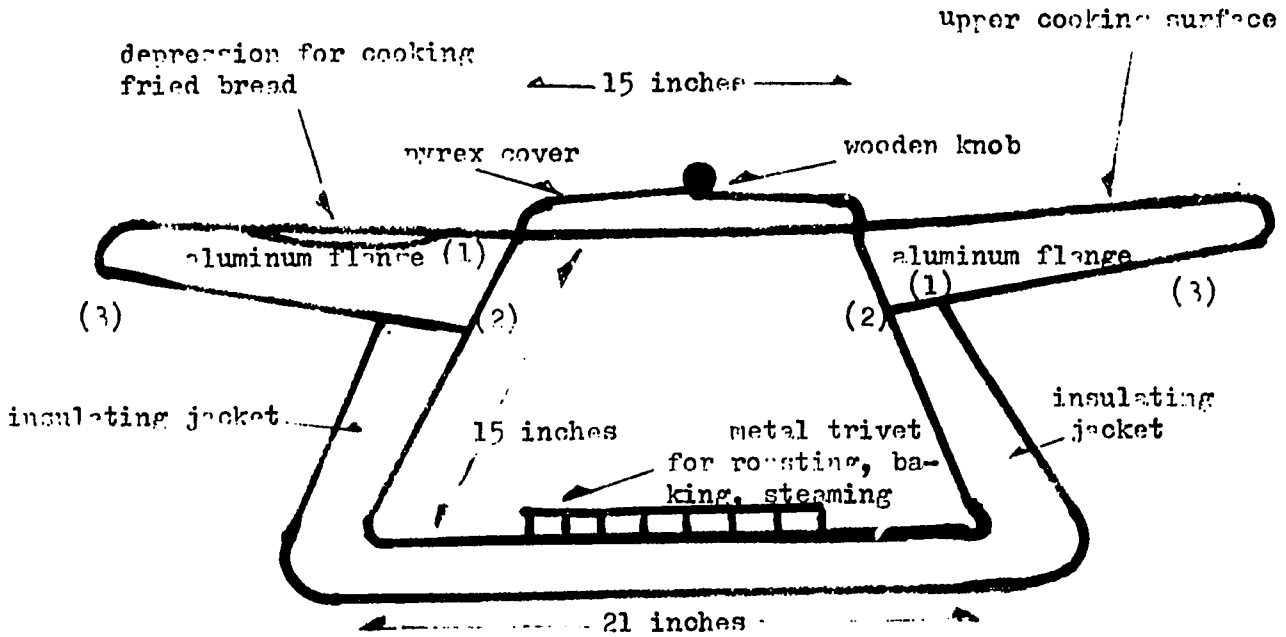
3.7.1.2 Biogas Generation and Cooking

Traditional disposal of human waste in Yemen lends itself well to waste collection for biogas production. As mentioned, usual disposal of excrement is through a drop into a ground floor room, a pit, or onto the open ground beside the house. From these sites, it is often collected for fertilizer or for cooking fuel.

Disposal into a container which could feed a biogas generator would improve sanitation, while not eliminating its usefulness as fertilizer. (The slurry remaining in the biogas generator after burning off gas is an excellent fertilizer, and one that does not carry human diseases as does the raw human waste.) Its value as fertilizer would be increased considerably if human urine, now allowed to drain through the village, were used to provide the necessary fluid for the generator mix since urine would help to increase the nitrogen content. At the same time, community hygiene would be considerably improved since urine is a carrier of disease--particularly bilharzia--and like other ground liquid run-off, eventually drains into the village cistern.

FIGURE 1

CAST ALUMINUM SOLAR COOKER, MULTI-PURPOSE, BASED ON TRADITIONAL YEMENI WOOD/DUNG-FIRED "TANNUR"



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(1) The aluminum flange would protrude on three sides only, leaving one side open where women would stand.

(2) Interior surface of cooking wall would have uneven surface, i.e., corrugated or gently ridged to assure the adhesion of dough used in making Yemeni flat bread; this would simulate uneven surface of traditional Yemeni ceramic stoves.

(3) Dimensions of the aluminum flange will have to be determined by testing under Yemeni conditions.

Yemen Metals Manufacturing and Trading Company in Taiz operates a small foundry utilizing scrap and trimmings from their utensil production line. They should be capable of casting solar cookers.

In addition to the family's human waste, animal dung and organic kitchen waste could be fed to a biogas generator. Ms. Obermeyer (Save the Children Foundation) reports that the waste of a Yemeni family of five or more should be able to produce enough biogas to provide for all of its cooking fuel needs. For a family of less than five, the system would not be practicable.

Where cooking continues to take place in the kitchen by means of smoke-producing fuels, exhaust fans would be effective in drawing smoke out through the smoke holes.

Two other food preparation chores that could benefit from the intro duction of appropriate labor-saving equipment are: (1) the home milling of flour--which is still done by grinding on a stone or cement mortar, and (2) the preparation of buttermilk (and butter)--which is customarily accomplished by shaking milk (goat, sheep or cow) in a gourd in which it had been placed to sour.

3.7.1.3 Using Roofs for Water Supply

Characteristically, Yemeni house roofs have multi-leveled sections. We suggest that one section be set aside for the solar oven/stove, and the rest of the roof be used for rain catchment. The water supply in the traditional bathroom was described earlier. The water supply of the typical kitchen consists of one or more large ceramic containers (30 inches high) which are filled as needed by means of cans of water carried from the household water storage tank. Water is brought to this tank by women or children who carry it up two or three stories in several time and energy-consuming trips per day. This water has been hauled from the communal water source, a well or a public cistern, by head-loading if the source is nearby, or by donkey, if at a distance.

Each section of the roof typically has a down spout to drain off rain water. We suggest that a locally available galvanized steel sheet water storage tank supported on poles or a steel frame be placed so that the down spouts lead into an opening at the top of the tank. Water thus caught would remain relatively clean in the covered tank. In order for water to be delivered clean to the tank, it would be necessary to cement or to tile the typical mud surface of the roof. A concrete or tiled surface for the cooking section of the roof is also recommended in order to make the cooking area more hygienic and to create a more pleasant work environment, particularly during the rainy season.

Even the African-style, conical grass roofs of Tihama (coastal plain) houses can serve as water catchments. the UNICEF publication, Village Technology in Eastern Africa (Nairobi, 1976, p. 33), suggests

a polyethylene film equipped with a sediment trap to remove dirt from the first running; alternatively, the first running can be allowed to discharge as waste until cleaner water can be caught. African-type conical grass houses in the Tihama area are single storied and therefore ground level catchments would be practical, perhaps in metal drums or concrete tanks which could be covered after being filled with water.

Catchment and storage of rain water should reduce the amount of water drawn for the home from the community supply. It should also reduce considerably the time expended by women and children in hauling water to the home. If children were freed from this task, perhaps school attendance might increase from the present 20 percent for boys and one percent for girls.

When water is needed from the central community source, it could be stored in the same tanks that catch the rain water. To eliminate the need for the arduous hauling of this water to a roof tank, water could be put in a large container which could be hooked to a pulley alongside the house. A donkey could be hitched to the other end of the pulley in such a way that when the donkey is lead away from the house, the container is lifted to the roof level. (In the villages we visited, about half the families own a donkey. These owners rent their donkeys to non-owners for water haulage.)

Should a woman have to handle this job herself, she could attach the water container to the pulley and lead the donkey to a hitching post set at the distance required to lift the container to roof level. Once the donkey was hitched, she could climb to the roof and empty the container by tilting it over a water tank.

This process might be further simplified in cases where the donkey has been used to haul water to the house. There is a rubber container carried by donkeys in Yemen which could be hitched directly to the pulley Several such donkey-back water carriers were observed in a visit to the village of Al Kowla, 25 km. east of Dhamar. This container, modeled after a traditional goatskin container, is itself an excellent example of appropriate technology--which could well be introduced to other areas of Yemen and the developing world. The container, which fits across the donkey's back like a saddle, is made from inner tubes originally from trucks or tractors. Sections of the container hang down on either side of the donkey, forming bags. At the lowest corner of each bag is a hole fitted with a small section of rubber hose, which in turn is stoppered with a small corncob. The center section (across the donkey's back) is fitted with a tube about nine inches long and four inches across, into which water is poured to fill the bags.

Perhaps this container could be placed over a leather or canvass strip placed like a saddle blanket on the donkey's back. The ends of this strip could be fitted with strong rings which could be hooked to the pulley. The belt would then encircle the water container which could be hoisted to the roof by means of the pulley. The filling tube would have to be fitted with a stopper to prevent water spillage as the container is carried upward.

Figures 2 and 3, starting on the next page, illustrate the concept described above.

To provide a convenient source of water for the kitchen and bathroom, pipes could be attached to one of the elevated storage tanks to lead to a water storage tank in the room. One possible type of tank observed in a bathroom in a rural home was made by constructing a half wall of concrete across a corner of the room, thus converting part of the room itself into a water tank. A spigot was set low on the half wall and used to fill cans for bathing and flushing. A hose with shower head could easily be attached to the spigot. This type of tank, perhaps raised from the floor by a steel or wood frame, or a cement base, could well be used in the kitchen as well as the bathroom.

Alternatively, manufactured tanks of galvanized metal sheeting or plastic, similarly filled by a pipe from the elevated storage tank on the roof, could supply water to the kitchen or bathroom.

In the bathroom, a second pipe from a roof tank might lead to a shower. To provide hot water for the shower, the water tank leading to the shower could be painted black and fitted with a clear, plastic, rather than a metal, cover. In this way, the tank would serve as a solar water heater.

We recognize that bathing is a religious activity in Islam, and that bathing facilities are attached to the mosque. This, of course, compensates to an extent for the deficiency of home bathing facilities. Nevertheless, provision of easily installed and operated home bathing facilities should greatly improve standards of personal hygiene, particularly for women and children who do not often visit the mosque. Such home bathing would be used before meals which are served in the home, as required by Moslem custom.

Similarly, better water facilities in the kitchen should simplify, and therefore encourage, kitchen and food hygiene. Kitchen hygiene would be further encouraged by such simple equipment as dish drainers, shelves for storing cooking and eating utensils, flypaper, fly swatters, window screens, and covered containers for the small quantities of food stored in the kitchen.

FIGURE 2

INNER-TUBE WATER CONTAINER TO BE HOISTED BY PULLEY FROM DONKEY'S BACK TO ROOF TANK

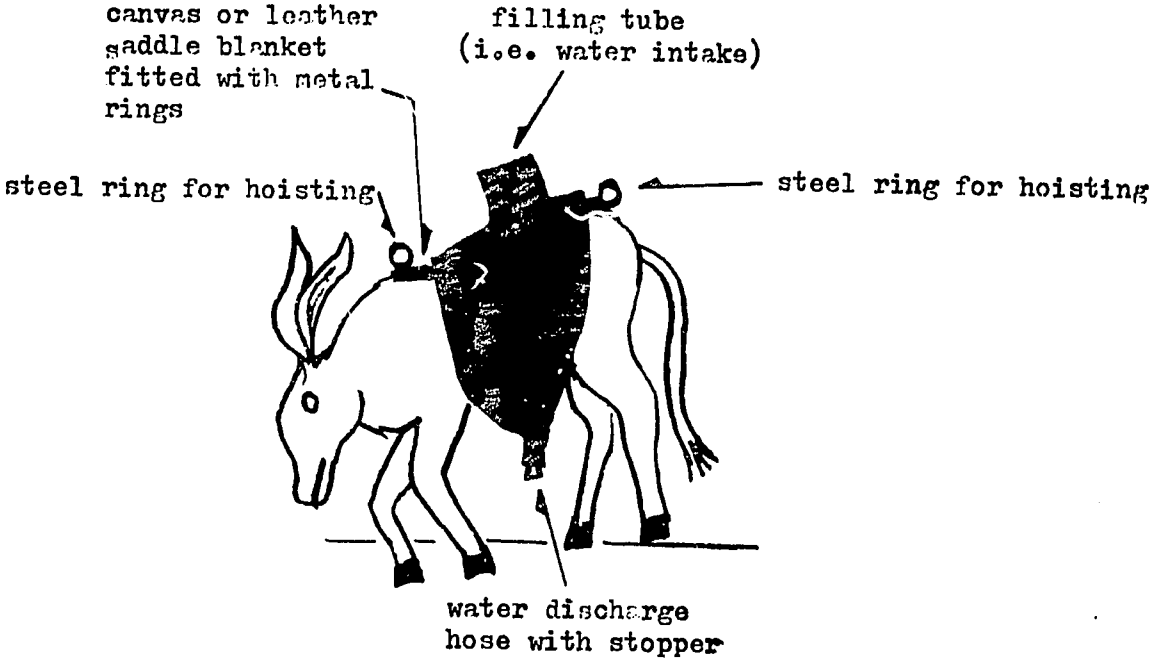
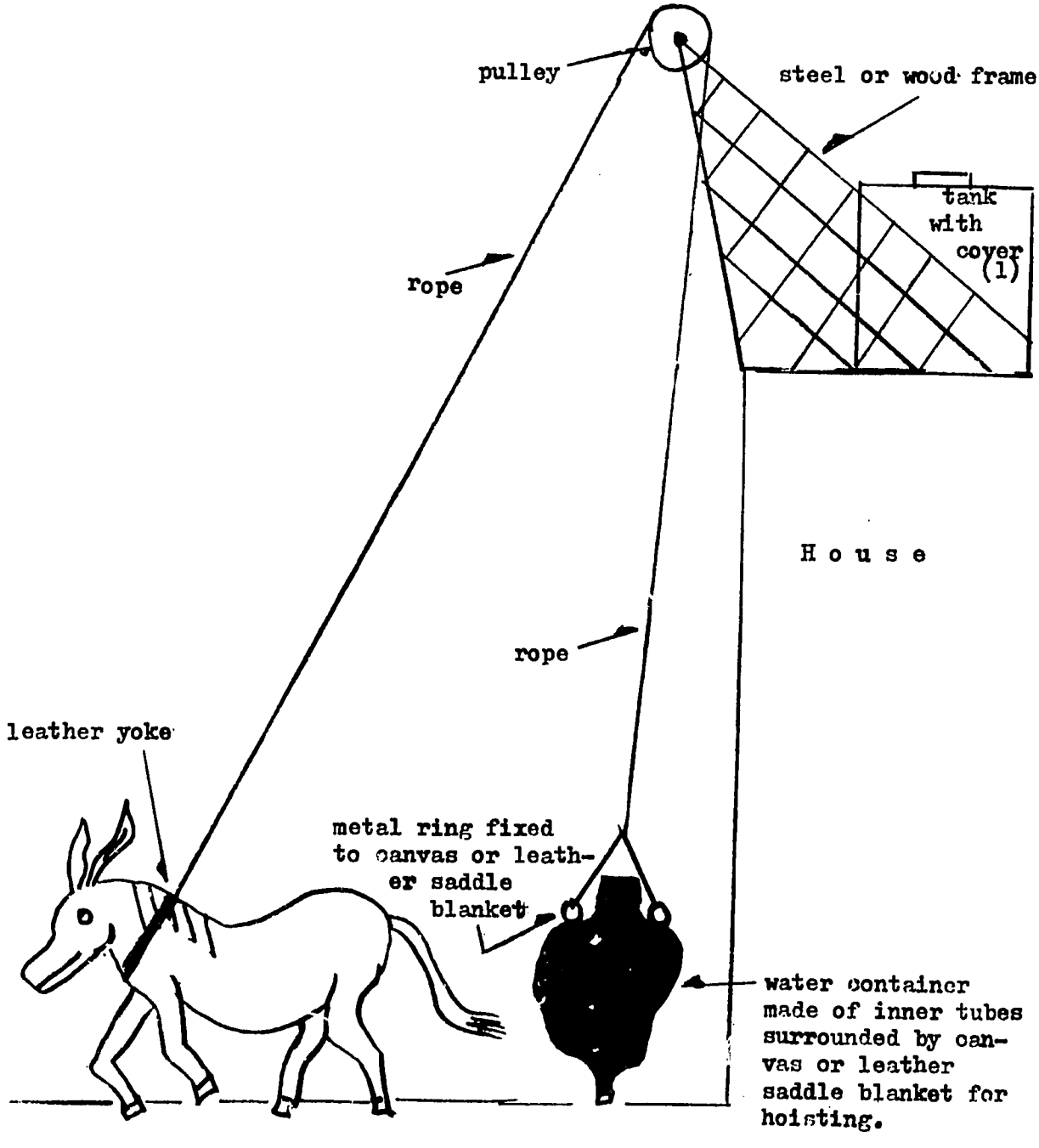


FIGURE 3

HOISTING INNER-TUBE WATER CONTAINER FROM GROUND LEVEL TO ROOF TOP TANK



(1) Tank should be placed so that left-hand side would be flush with house wall; this would facilitate the movement of the container to a position where water would flow into the tank.

Where water contains particulate dirt, Yemeni women express a desire for cleaner water. Where possible, this desire should be exploited to motivate those who can afford it to buy water filters. In cases where--for reasons of cost--this would not be feasible, small removable strainers could be fitted into kitchen pipe outlets.

In some homes, dish washing is done on the roof. This is a good hygienic practice since dishes are then allowed to dry in the sun--although often on a dirty surface. The aforementioned dish drainers could serve well in this situation, and provision for a spigot in a roof tank--to eliminate the need for carrying dish water to the roof--is also suggested. This tank might be the same one designed for solar heating of shower water so that hot water washing would further improve the sanitation of eating utensils.

3.7.1.4 Food Storage and Preservation

Life expectancy in the Yemen Arab Republic is among the lowest in the world, with estimates ranging from 37 years (Washington Post, September 6, 1978, p. 18) to between 40 and 45 years (W.H.O./Yemen Arab Republic National Health Program, 1976/1977-1981-1982, p. 12). Diarrheal diseases are given highest priority by health officials, followed by tuberculosis.

The first of these diseases is spread primarily, and the second, in part, by poor food hygiene. Food hygiene, as well as food quantity and quality could be greatly increased by better methods of home food storage and preservation.

Food storage--mainly of cereals (sorghum, millet, wheat, barley)--whether in the traditional pits dug into the ground below the house, cavelike holes (medfan) in nearby rocks, cement bins, or in ceramic or metal (oil drum) containers, permits spoilage and infestation of the grain, particularly in the wet season when moisture enters the storage container.

Suggested improvements in traditional home food storage follow.

Preparation of grain for storage: Traditionally, grain is threshed, winnowed and dried before storage. Threshing is done by men who beat the heads of the freshly harvested stalks of grain against a suitable flat rock or specially constructed concrete slab. The grains thus released are then winnowed by the women who toss grain by hand into the air where the chaff is blown away. The grains are then spread to dry in the sun on the same flat rock or cement slab used in threshing. This procedure, while relatively efficient, is wasteful, does not allow for complete winnowing and does allow for contamination of the grain by the ever-present dust, insects and other parasites.

Earlier in this chapter, machines designed for more efficient threshing and winnowing of grains are described. For more efficient drying of the grains (as well as destruction of insect infestation), a simple solar dryer is suggested. This would consist, basically, of a black metal box of a size suitable for the amount of grain to be dried, and fitted with a cover of clear plastic. This box would accumulate a substantial amount of heat which effectively dries the grains and kills insects, larvae and eggs. Ventilation holes near the top of the box must be provided to allow moisture from the dried grains to evaporate. Other holes near the bottom of the box allow for the entrance of fresh air. Where there is danger of rain introducing moisture through the air-holes into the dryer, the cover could have a protective overhang.

Figure 4 on the following page illustrates a possible design for the solar dryer described above.

Such a dryer could be homemade, perhaps with locally available metal trunks (minus cover), or it could be factory produced.

Cerals dried in the suggested manner to the point where they can be crushed to a dry flour between two stones should store without spoilage if protected from moisture and insect infestation.

In addition to the recommended thorough drying at high temperature and storage in insect and rodent-proof sealed containers, other measures that can be taken to protect stored grains from insect infestation include (1) mixing ash, sand or siliceous earth with stored grain; (2) mixing plants having insect repellent properties with the grain (examples include pennyroyal, mint, tansy, garlic, wormwood, etc.); (3) burning a candle mounted inside a tin can in the grain storage container to reduce its oxygen content before sealing.

The measures recommended above for protecting grain from insect infestation are much safer than the use of imported insecticides, such as DDT, which have recently become common in Yemen. Such insecticides represent a real danger in the hands of illiterate consumers. (The literacy rate for Yemen has been estimated at about ten percent, and close to zero for women, who have the major responsibility for grain storage.)

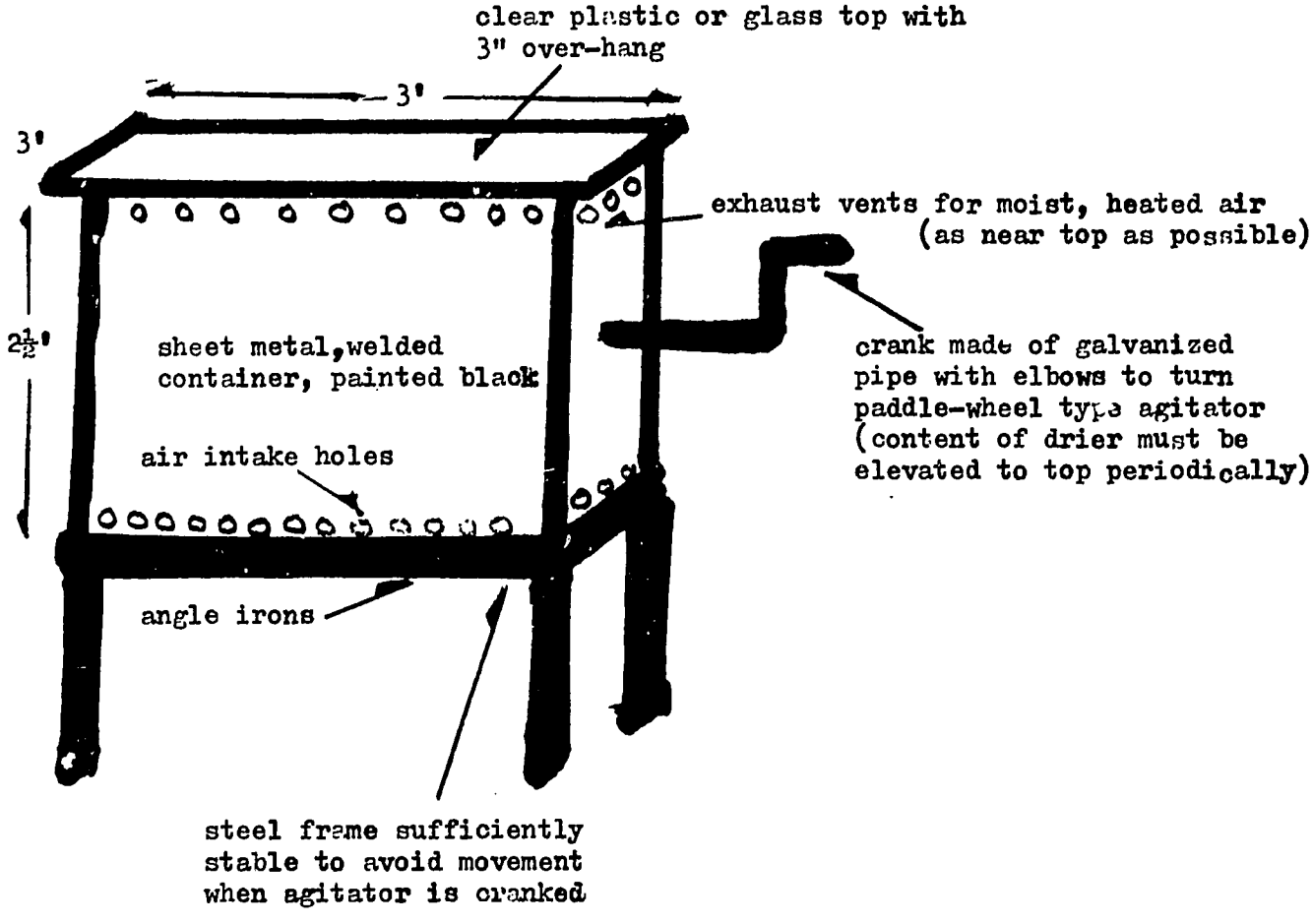
Where insecticides must be used, pyrethhrum products are suggested. These are made from a dried natural flower which appears to be non-toxic for humans.

3.7.1.5 Protection of Grain During Storage

Where sunken pits are used for grain storage, they would be improved by having a concrete liner and a tight fitting, sealable cover. These could be easily provided by placing in the pit a

FIGURE 4

SOLAR DRYER MOUNTED ON ANGLE-IRON FRAME
(FOR GRAIN, VEGETABLE, FRUIT DRYING)



container which has been greased on the outside, and which is slightly smaller than the pit itself. Cement would then be poured around the container. In a large pit, two or more such containers could be grouped, cement poured into the spaces, producing a cement block with bins for several grains.

Containers (boxes, barrels, or drums) used for moulding as described above, could be community property, and loaned as needed to any resident.

Dried fish is another type of food which can be preserved for long periods by various drying processes. Although fish can be dried by fire and/or smoke, on the coast of Yemen where there is much sunshine and the air is hot and dry, sun drying--possibly combined with salting--should prove a good and simple drying method. Fish can be cleaned; kept whole if small, split down the middle into two halves if of moderate size, or sliced--either lengthwise or in cross sections. If the fish are very large, they can be soaked in pails of salt water, fileted, and then suspended on a frame to dry in the sun. Alternatively, fish could be suspended without soaking, but, several times during the drying process, pails of sea water could be poured on and the evaporation of sea water would provide for salting. Either method would yield extra protein for family nutrition. Should there be a surplus of preserved fish, some could be sold in markets throughout the country, since the shelf life and traveling quality of salt fish is good. (Estimates for spoilage of coastal fish shipped fresh to inland markets range as high as 70 percent.)

Eventually, should the Yemeni Red Sea fishing industry grow sufficiently to export fish, salt fish could readily find overseas markets. Salted shark is a favorite food in much of the Middle East, and could provide the basis of an export industry.

Where there is a demand for smoked rather than salt fish, a simple home fish smoker could be made as follows: remove the ends of a used (and cleaned) oil drum to produce a metal cylinder; suspend this cylinder over an outdoor fireplace; lay a metal grid agross the top; fish (or other food, such as meat or corn-on-the-cob) could be suspended with twine or wire from the grid. The metal cylinder acts as a chimney through which smoke is drawn upward, thereby passing over the suspended food, which will be heated, and therefore, dried at the same time.

In communities with electricity, some modern refrigerators are used for home food preservation. In others, butane gas or kerosene refrigerators are used although the cost is too high for most families. An attempt should be made to locate or produce less expensive refrigerators using these fuels. Possibly biogas could also serve to fuel a refrigerator. Large community freezers in which families could rent space would be appropriate for Yemeni villages. In fact, such equipment, usually of Italian manufacture, is already being introduced.

3.7.2 Technologies for Health and Nutrition

3.7.2.1 Improved Nutrition Through Food Cultivation and Storage

Intensive fish farming. Cultivated fresh water fish might be preserved in the same way as described above for ocean fish. Yemen has some mountain springs which could be harnessed for the intensive farming of fresh water fish, such as the Tilapia (also known as milk fish), African perch, or catfish.

By intensive fish farming, we refer to the technique of growing a large number of fish in a small tank made of concrete, metal or wood, approximately six feet long, three feet deep and three feet wide. Mr. Reneh Haller of Bamburi Cement Works, Mombassa, Kenya, has been successfully cultivating enough tilapia or catfish in a tank of that size to supply an average Kenya family (about eight people) with all its protein needs.

The intensive fish farming method requires that water be kept constantly flowing through the tank. Normally, fish in crowded conditions undergo runting, due to a lack of oxygen and the accumulation in their water habitat of a growth-inhibiting hormone. If this hormone is constantly washed from the tank, runting is avoided. A better oxygen supply permits the culture of more fish per cubic meter than is possible in stagnant water. If the fish are supplied with enough algae and/or other food, they will grow rapidly to full size even in the crowded tank. Mr. Haller, to demonstrate the effectiveness of his method, keeps water constantly running through his tanks by pumping it from the abandoned quarry which is the site of his experiments. Such a method would probably be impractical in most areas of Yemen, but the same result could be obtained by letting the water of a mountain spring flow by gravity through the fish tank. The tank would be placed downhill from the spring and water could be channeled through PVC pipes. If the water source is a hot spring, a holding tank should be provided, of a size sufficient to allow the water to cool to a suitable temperature.

The small fish tank will be too crowded to allow for the growth of algae to feed the fish; a separate tank, or a pond, for the cultivation of algae may be necessary. Fish could also be fed from grain residue and other vegetable waste. Dung from the various domestic animals as well as fish excreta in the runoff from the fish tank could be used to fertilize the algae. Run-off from the tanks could be used to irrigate and fertilize crops. Such crops might be chosen to compensate for local nutritional deficiencies. Typically in Yemen there is serious shortage of vitamins A and C. These could be supplied by fruits--mango, papaya, berries, citrus (less rich in vitamin A) or vegetables such as broccoli, kale, Brussels sprouts or carrots.

If there is enough water from the spring, two or more fish tanks could be supplied. This is recommended as preferable to one large tank, since damage to one tank would not endanger the whole fish crop. The same is true of possible diseases entering a tank. Also, different types of fish with different feeding requirements could be cultured in the different tanks.

Should there be more water from the spring than the food production system requires, the remaining supply could be piped down the hill in the opposite direction from the fish tanks for the provision of hygienic water for human consumption. A first standpipe could provide water for drinking; a lower one could provide water for bathing facilities; at the same level or lower, a third outlet could provide water for laundry facilities.

Preliminary to instituting a country-wide program of mountain spring fish farming, there would have to be a program to identify and map existing springs. Information would be needed on the volume of flow, the permanence or seasonal duration of flow and the chemical content. The latter information is needed to select appropriate fish species for a given spring. Information concerning the duration of flow is needed to determine whether the spring could support fish farming. A seasonal spring may flow long enough to support a crop of fish even though it may not support fish farming year round. For example, some cultured fish need only six months to reach maximum size. Where a seasonal spring could be depended on to flow for at least six months, fingerlings could be introduced as seasonal flow begins. Harvest could begin in six months and continue for as long as the spring water continued to flow. When the flow stops, the remainder of the fish could be harvested. If there should be too many fish for immediate consumption (or local sale), the fish preservation methods suggested in the previous section could be used to provide a good source of protein during the dry period.

Since the proposed method of intensive fish farming requires no great physical strength, it could easily be handled by women.

Fish farming, where feasible, and fish preservation are particularly appropriate technologies for Yemen inasmuch as the general diet consisting as it does overwhelmingly of cereals is deficient in protein.

To remedy vitamin C deficiency, more citrus fruit in the Yemeni diet would be desirable. There is one technology for irrigating citrus trees that suggested itself during field trips to mountainous areas. Citrus trees could be grown on terraces in quite dry regions with the aid of simple drip irrigation. Yemeni terraces are designed to slope downwards toward their outer perimeter. Tin cans could be placed in holes uphill from each tree. A few holes could be punched on one side of each can, and the can placed so that the holes face the tree at root level. Each can could be periodially filled with water at times

appropriate to the growing habits of the tree. This method of irrigation provides water to the tree so that all is directly applied to tree roots and none is wasted by evaporation from leaves or ground, nor by drainage away from the roots.

Where a spring exists, it could be used for the drip irrigation of citrus, as well as other crops by means of plastic hoses laid throughout the field, with holes directed to the roots of each tree.

Plastic hoses (and the PVC pipes suggested in the spring fish culture system) are appropriate for Yemen since they are domestically produced in a plastic factory just north of Taiz. In the first drip system mentioned above, domestically produced plastic containers might substitute for the cans ordinarily used.

Another appropriate method for providing moisture for crops would be dew irrigation. On a small scale, women might use this method in the courtyard of the home--for example, a mango, guava, or papaya tree (to supply fruits which have very high content of vitamin A and vitamin C).

Dew irrigation of such trees could be accomplished by filling a small trench around the base of the tree--dug wide enough to cover the width of its roots with small pebbles. The dew which collects on the surface of the top pebbles in the early morning will percolate to the lower pebbles where the moisture will be protected from evaporation while percolating further down to the tree roots during the day.

On a larger scale, dew irrigation could be applied to terraced tree plantations by placing a trench of pebbles behind each row of trees.

A national nutrition survey for Yemen under World Bank and AID sponsorship is planned for the near future. Once national nutrition needs have been more precisely identified, a flour enrichment program should be instituted whereby deficient vitamins, minerals, and perhaps proteins (soy flour, or specific amino acids) are added to all supplies of the imported unenriched white flour before it is marketed to consumers. This white refined wheat flour is much lower in proteins, iron and vitamins than the traditional Yemeni sorghum flour. As the popularity of white flour continues to grow, and as it is increasingly substituted for traditional flours, it may be anticipated that, without enrichment, nutritional standards of the country will continue to decline.

Another special food needed is a nutritionally adequate weaning mix for infants. There appears to be a trend for Yemeni women to abandon or shorten breast feeding. Imported baby formulas are popular and, unlike much of the developing world, formulas are affordable by a large part of the population. As in the rest of the developing world, however,

formulas are often misused--by overdilution and lack of necessary sanitary precautions--thereby contributing greatly to the serious and often fatal nutritional and gastrointestinal disorders of infants.

Research should be conducted to determine the possibility of using traditional local foods as the basis for weaning foods. Variations for each area should be designed to take into account seasonal crops. Possibly this research, including field testing, could be conducted by the nutrition office within the Ministry of Health.

Where baby formulas are being used, attempts should be made to insure that equipment and instruction for their proper preparation and use are available to mothers. Perhaps companies which export formulas should be encouraged to devise visual rather than written instructions for countries like Yemen where virtually all mothers are illiterate.

3.7.2.2 Technologies for Health and Hygiene Improvement

One health/hygiene problem that affects nutritional standards in Yemen is the deficiency of sunshine suffered by many women and small children. (Since small boys grow to be men, the effects are suffered by men as well.) Sun deprivation is a common phenomenon where women live in seclusion and are veiled outdoors. Small children are secluded within their mothers garments and, when babies are taken out of the house, they are often carried under the mother's veil. Thus, a paradox exists where children suffer from rickets in a land of abundant sunshine. A related adult disease, osteomalacia, is also prevalent in Yemen. Since little milk is consumed in Yemen, calcium as well as vitamin D deficiency may contribute to the prevalence of these diseases.

It is hard to see how veiled mothers will get enough sunshine, since the Yemeni home is designed to keep heat and, therefore, to keep the sun out. For babies, airing in carriages or in specially designed window cages or in playpens on rooftops might be recommended. For young children, less clothing in warm weather would be appropriate. The Maternal/Child Health Project (of the Catholic Relief Service) in Hodeida claims progress in persuading mothers to use western style rather than traditional clothes for children, a practice they recommend because in these clothes, children's arms and legs would be more exposed to sunshine. Education for modification of children's clothing to allow for sun exposure, whether such clothes be western or traditional style, imported or homemade, would be appropriate in all areas of Yemen.

To provide for increased needs of calcium as well as vitamin D for pregnant and lactating women, appropriate supplementation of their diets might be considered.

Another health problem of mothers and babies is the grossly unsanitary obstetrical environment. In most areas of Yemen, the mother gives birth at home, attended by her mother-in-law or her own mother. The first child is ordinarily born in the home of a woman's parents to which she returns for the birth. Failing the availability of a female relative, the mother may be attended by a traditional midwife. In some communities, the local midwife is the usual attendant. Whether a relative or a professional midwife, however, the birth attendant is ignorant of simple obstetrical hygiene and lacks the equipment to provide even minimal sanitation. We obtained from Dr. Fadlalah, of the C.R.S. Hodeida Maternal/Child Health project cited above, a list of items (listed below) to be included in an obstetrical kit which could be used by the traditional midwife after some training. With some modification, this kit could be used by the untrained birth attendant as well. Although use of the kit would not provide for a perfect obstetrical environment, it should improve the current situation considerably.

Dr. Fadlalah suggested the following items be included in the obstetrical kit: (1) lysol solution; (2) rubber gloves; (3) forceps; (4) gauze bandages and compresses; (5) injection supplies for antihemmorggic drugs, cardiac drugs, antibiotics, antitetanus vaccine, vitamin E. The above list is cited merely as a suggestion. Any medical kit should certainly be carefully supervised by appropriate medical personnel.

The obstetrical kits could be owned by a local clinic--where one exists--or by the Local Development Authority (LDA) or some other community organization where no clinic exists. It could be available for loan to a birth attendant. Where there is a clinic, instruction might be offered to the borrower. Elsewhere, the expected attendant might be asked to visit a neighboring clinic for advice, or some local woman could be trained to instruct other women in the use of the kit.

Borrowers should be required to return the kit in its original hygienic condition. Where this is not feasible, a rental fee might be charged and some specially trained person assigned to prepare the kit for reuse.

A second kit--for circumcision--might also be provided for community use on the same basis as the maternity kit. The usual village circumciser is a religious leader attached to the mosque, the muezzin or the imam. The prevalence of dust in most areas causes lesions to infect quite readily.

Expansion of the immunization program to include all children in the country is an obvious and urgent health need.

3.7.2.3 Community Sanitation Technologies

Many of the suggestions on home improvement earlier in this section of the report were designed for the improvement of home hygiene. There is an urgent need to improve community hygiene as well as to improve the health of the rural population.

The most urgent community hygiene need is the provision of a sanitary water supply. In the discussion on use of mountain springs for fish and food cultivation, a suggestion was included for the provision of a sanitary water supply from mountain springs. Where water is provided by wells or cisterns, other provisions to protect the water supply are needed. Some suggestions follow:

(1) Wells and cisterns should be covered when not in use to reduce contamination, and prevent mosquito breeding.

(2) Where women are accustomed to doing their laundry near the water source, rather than in their own homes, laundry facilities should be provided near the source of water, but far enough away so that wash water would not contaminate the drinking water supply. The laundry facility might include wash basins at a convenient height. The bottoms of the basins should slope so that the volume of wash water can be adjusted to the amount of wash. This would serve to conserve water and would simulate the situation of traditional laundering in various villages, i.e., the use of natural basins in rock outcroppings near the wells. To simulate the customary practice of rubbing laundry against the uneven surfaces of the rock, the sloping side of washing sinks could be corrugated, like a washboard. Other sinks, to be used for rinsing, could be smooth-bottomed, again, to conserve water. Where possible, water could be piped to the laundry facilities, either by means of pumps, or by gravity, as mentioned for the spring system described earlier. If piped water is not feasible, women could bring water to the laundry area in the traditional manner, i.e., head-loaded or by donkey carriage.

As many units could be provided as are needed for the size of the population using the facility.

The sequence of sinks would be designed to avoid the possibility of one woman splashing her soapy water into another woman's clear water. Sinks could be made locally of concrete, or factory-made of galvanized sheet metal or heavy plastic.

Where such sinks are not appropriate, simple washboards--which would be easier on both laundress and clothes--could be made available.

A communal drying area, with wash lines over a cement floor, could also be provided to reduce the risk of wash being soiled during the drying process by dust and mud.

Where women prefer to dry their laundry at or near home, they should be encouraged to use roof-top wash lines or other apparatus for hanging laundry rather than spreading it on the ground or draping it over bushes, practices which may infest clean laundry with harmful insects as well as dirt.

When a community is electrified, the community laundry area could be provided with a public "laundromat" using machines that are designed to recycle, or otherwise conserve water.

Community drinking water supplies should be protected from use for human bathing and animal watering.

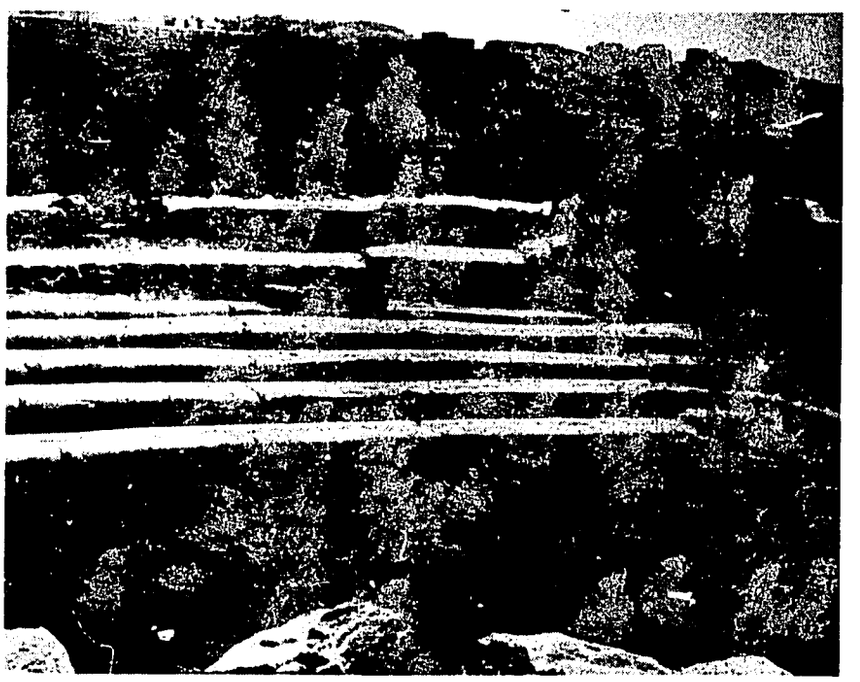
Another community hygiene measure needed to protect the health of residents is the regular collection of trash. A professional trash collector, probably a member of a local servant caste (see Annex B to this report) should be hired for this job. Recommended simple equipment for trash collection includes: (1) a long stick with a projecting spike at one end for picking up paper trash and (2) another stick with a scoop at one end for picking up animal dung. Metal, chiefly tin cans and other solid trash could be picked up by hand or by means of a (3) long handled shovel. The collector could be provided with a (4) cart with (5) three containers lined with plastic bags, or (6) the plastic bags could be suspended from a belt around the trash collector's waist. The paper waste might be compacted to be used as fuel or destroyed by burning in (7) an incinerator; the animal dung could be used as fertilizer possibly after being used for biogas production; the metal waste could be compacted for recycling or disposal in small-scale solid waste disposal units.

Home hygiene could also benefit from convenient receptacles for trash collection--plastic bags for solid, and plastic containers for liquid waste.

Channels for water run-off during rains are seen quite often, as are cisterns for collecting this water. Such systems should be provided in communities where they do not exist. Where they are present, they should be maintained, or improved so as to eliminate the standing pools of water in which the bilharzia snail flourishes. As mentioned earlier, the cistern itself must be protected from contamination.

Since the health of the family is largely in the hands of the mother, education for girls can be considered a health promotion measure. Currently, almost 100 percent of rural women in Yemen are

This uncovered public cistern in a village located in the outskirts of Turbah, contains stagnant water contaminated by the dung-laden run-off from about half the village. There is evidence of mosquito breeding as well.



illiterate. That this in part stems from reluctance of Yemeni parents to permit daughters to take daily trips to school is indicated by school registration figures cited in a study of the town of Mahweet (Hart & Tutwiler, item 31 in Annex D, Bibliography for this report) which has "a student population of around 620. Of these pupils, about 20 are girls whose families live in Mahweet. The boys come from the entire nahiya ..." (Mahweet nahiya refers to the subdistrict or subdivision of the governorate in which the town of Mahweet is located.)

Discussion with Ms. Osman Pasha, of the Central Planning Office, Y.A.R., suggests that if an adequately supervised dormitory for girls were provided near schools, a significant number of parents would be likely to enroll their daughters. Such a dormitory would also provide an ideal situation for girls to learn better practices regarding hygiene, nutrition, and home management. This would supplement their school instruction and thus prepare them to be more effective protectors of the family's health. Helping to launch and manage these dormitories might be an appropriate area for Peace Corps involvement, although supervision by respected Yemeni women is essential to assure parents that the facility is suitable for their daughters.

Existing and proposed schools should include in their curriculum courses which provide instruction in crop cultivation, preparation and preservation of food, nutrition, hygiene and consumer education. In this way, the young will become an additional resource for proselytizing appropriate technology in Yemen where much foreign technology is being hastily introduced without a careful discrimination of the good from the unsuitable.

3.8 Priority Technologies for Initial Action

Summarized below are the types of technologies that would probably warrant priority action in the event that a program is started to introduce appropriate technology. In some cases, the most urgent need is not necessarily for specific equipment but rather for systems involving equipment plus local supporting facilities. The priority technologies are described below.

3.8.1 Irrigation Systems

The introduction of mechanical drilling equipment and deep well pumps is revolutionizing Yemeni agriculture. It is also leading to a wastage of water and a lowering of the water table in many areas, such as Sanaa and Hoeida.

At least three technological problems appear to justify study:

(a) Most appropriate types of pumps;

(b) Appropriate spacing of wells and pumps; and

(c) Reduction of water losses in conveying water between the well head and the field.

The last problem, which can involve the loss of almost half of the water, requires special attention. The British Agricultural Engineering Group at Taiz plans to test plastic lined channels. The German group at Al Boun are testing concrete pipe to reduce losses caused by spillage out of the channel, evaporation and percolation.

3.8.2 Grain Storage

In many farming areas, grain is stored in ceramic-lined pits sunk in the ground with a dung-sealed lid to reduce the oxygen and moisture available to insects. In other areas, grain is stored in jute bags with consequent losses from infestation. A few farmers use discarded oil drums which are convenient, water proof, easily fumigated and are of small size.

An analysis of grain storage technology has been made by VITA (Publication 35E, September, 1976). The technologies suggested by VITA, as well as others developed in the Far East and Pakistan, should be analyzed to determine their suitability for Yemen.

3.8.3 Tractors

At present, about 4,000 tractors, averaging 50 horsepower each, are in use. Of the total, only some 2,500 are in operating

condition according to a UNIDO report. (See Annex D, Item 40.) Expert opinion is divided on the advisability of importing large tractors in the 80 horsepower range, and deep-plowing is a controversial subject. The evidence is strong, however, that deep-plowing is expensive--about four times higher per hectare than plowing by tractor-drawn chisel plows. It is also evident that deep-plowing reduces moisture in the soil.

Considerable opinion favors the use of ten horsepower walking tractors (single axle) for smaller farms and terrace agriculture. A commercial impact is already noticeable due to the import of Danish, Korean, and a few Japanese tractors in the five to ten horsepower range.

3.8.4 Threshers

A small four horsepower portable thresher has been tested for two seasons by the Yemen-British Agricultural Engineering group in Taiz. They report the thresher is ready for commercial application with modification, namely a screen to separate chaff from the grain.

Traditional threshing and winnowing practices are almost universal in Yemen. The traditional method is for bullocks, donkeys or camels to trample the grain and stalks until the grain is separated. Substantial hand labor is then involved in further separating inedible stalk fragments.

The threshing operation is usually conducted on a hard earth surface unless a stone (or sometimes concrete) surface is available. Aside from the introduction of dust and the ubiquitous dung, traditional threshing is inefficient, requires many hours of animal and human effort, and yields a high percentage of broken grains.

After the threshing is finished, the grain is winnowed entirely by manual methods; women throw the grain into the air so that the chaff is separated by the wind. On windless days, the winnowing must stop or, alternatively, the chaff is allowed to reunite with the grain, reducing the nutritional properties of the grain.

The introduction of something like a combine-thresher-winnower, such as that used for small-scale farming in Japan and Korea, is an urgent requirement for food-deficit and labor-short Yemen. The Japanese type of combine-thresher is self-propelled or tractor-drawn and usually powered by a 20 to 25 horsepower gasoline or diesel engine. The inedible forage material is baled automatically into a cube about 50 cm x 40 cm x 40 cm in size. For transport on mountain trails, this size cube is much more manageable than the larger U. S. or European bale. Blowers drive away the chaff, leaving a high percentage of unbroken grains.

3.8.5 Trailers for Farm Tractors

The tractor should become a multi-purpose, mobile power source for many activities in addition to soil preparation. The tractor/trailer combination and tractor trains offer many advantages, including the following:

(a) Damage to vehicles is less for village and off-the-road use than for trucks currently in use.

(b) Damage to highways is reduced because of slow speeds and low axle loading.

(c) Tractors now used in Yemen are suitable for highway use.

(d) Cost of transport per ton/mile is approximately half that of a truck and maintenance costs are less than for trucks.

(e) Single trailers could be fabricated in Yemen by re-cycling discarded truck axles and wheels.

(f) Multiple trailers or trains, e.g., six trailers forming a train, would have to be imported. Such trains could be used for heavy and bulky materials such as stone for construction and equipped with moveable sides or bottoms that allow discharge by gravity.

(g) Capacity utilization of the existing tractor fleet could be increased and, through fuller utilization, more farmers could afford tractors.

3.8.6 Pre-Fabricated Concrete Products

Concrete can become a substitute for stone and wood as a construction material and for most uses would be less expensive. (Stone cutters in Sanaa typically earn YR 425, or $94, per day.) In addition, concrete can be formed into pipe and other moulded shapes of value to rural development. Virtually all concrete products can be manufactured in village shops and a number, including pipe, could be produced by individual farmers. Concrete products have an important potential as a conduit to reduce irrigation water losses, often as high as 40 percent. Mechanical cement mixers and moulds are the major capital investment.

3.8.7. Modern Repair Shops

Modern repair facilities mentioned earlier in this chapter should be established in the larger towns to service the vehicle and tractor fleet of the rural hinterland. These should be supplemented by mobile repair vehicles with four-wheel drives capable of negotiating steep, unpaved trails. Volvo and Caterpillar are already using such mobile workshops.

Importers of equipment for each of the specialized shops could be asked to partially finance the training abroad (six months to one year each) of potential shop operators. The skills of the first fully competent automotive and diesel technicians would soon spread over the rural areas as apprentices, in turn, opened their own shops.

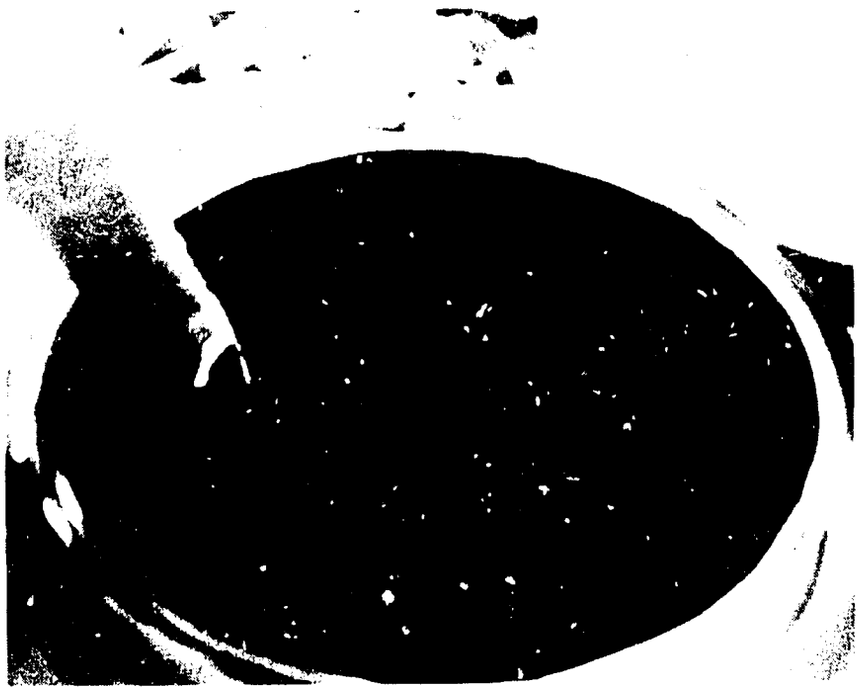
Yemen faces an increasing problem in the maintenance of diesel engines. The age of most diesel engines in Yemen ranges up to four years, since the surge in imports began in 1974. Many of these engines are used to power generators (for village electrification), compressors (for tire repair), tractors and trucks. After several thousand hours of operation, these engines will increasingly need repairs. This means that the number of breakdowns will rise rapidly in 1979 and beyond, suggesting a need for major improvements in the product support programs of importers of engines and associated equipment.

3.8.8. Home and Health

Some of the most urgent needs described in Section 3.7 of this Chapter include: (1) solar cooking and heating; (2) improved methods of hauling water to roof tanks for gravity flow to kitchens and bathrooms; (3) exhaust fans for kitchens; (4) better roof utilization, especially for water catchment; (5) standardized, sterile, kits for midwives and persons performing the circumcision ritual; (6) sanitary disposal or storage of human waste; and (7) collection and disposal of solid wastes.

Since 1974, Yemen has undergone many rapid changes, one of which is the increased volume of imports of canned, boxed, and otherwise packaged products. The streets of towns and villages--for the first time in history--are littered with PepsiCola cans, kleenex boxes, food cans, metal scrap, and polyethylene wrappers. No systematic provision for the disposal of solid waste exists in most communities, suggesting that community solid waste disposal units (such as those found in Japanese, Taiwanese and Korean villages) would warrant priority consideration.

A small-scale manufacturer in the outskirts of Turbah (40 km south of Taiz) makes a kerosene stove system consisting of an elevated tank, pipe, and burner. The burner and wick are shown here. The cylindrical oven for baking Arab flat bread (khubz) is shown below; the ridged inner surface is designed to make sure that dough adheres to the surface. The picture at the bottom of this page shows a diagram, painted on the plant manager's truck door; the diagram shows the entire system from the elevated tank (where the finger is pointing) to the bread oven on the left hand side of the diagram. The entire system costs $900 (YR 4,050). According to the producer, 600 of these stove systems have been sold over two years.



CHAPTER 4

POLICIES FOR IMPLEMENTING A PROGRAM TO INTRODUCE APPROPRIATE TECHNOLOGY

4.0 Introductory Comment

This Chapter outlines several policies which could be considered by the Yemen Arab Republic for encouraging the introduction of appropriate technologies.

Such policies would be designed to improve the selection of imported equipment, assure better performance on the part of machinery importers in product support and training, and bring about gradual improvements in living conditions and health.

Given the laissez-faire business tradition in Yemen, the authors believe that a range of incentives, promotional efforts, and consumer education would offer the greatest promise of success. The Government has available to it some legal measures to control the private sector, for example, the Import and Export Law (see excerpts in Annex E). However, the use of regulation and penalties would probably backfire because of the difficulties of enforcement and the strong tradition of free choices that exists in both the business and consuming communities.

4.1 Import Licenses

Imports for the year ended June 30, 1978, were valued at almost $1.4 billion, up from only $379 million two years earlier. (See Table 2.9 in Chapter 2). Careful screening of imports of this magnitude is hardly practicable given the limited staffing of the agencies involved.

Applications for imports are now examined by the Ministry of Agriculture or other Ministry responsible for the sector and then reviewed by the Ministries of Supply and Economy. The present policy is to approve virtually all applications. However, the present system could be changed to affect the import of goods that either hasten or retard national development.

4.2 Import Duties

Capital equipment is imported at duty levels up to 15 percent, with five and ten percent being typical. Since duties are established by law, any upward changes would require at least a Cabinet decision. However, the Ministry of Finance could lower rates if it were found desirable to encourage imports of technologies needed to strengthen the economy.

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4.3 Credit to Importers and Home Builders

A strong incentive within the power of the Government is to extend commercial credit to selected importing companies in order to attain specific objectives. (The Government already provides credit on special terms to small manufacturing companies.)

Through directives to financial institutions, the Ministry of Economy could make supplementary funds available to encourage the import of appropriate technologies deemed to be in the national interest. The following types of financing might be considered:

- Credit to be re-loaned by the importer to the purchasers of approved equipment and supplies.

- Credit to facilitate the import and testing of technology new to Yemen which is considered potentially promising.

- Credit to allow the importer to expand distribution and servicing facilities to rural areas, such as the mobile repair shops cited earlier.

- Credit to finance inventories of appropriate equipment.

- Credit to construction companies, builders or home owners, provided certain standards of construction, sanitation, and kitchen design were observed.

4.4 Income Tax Rebates

Inducements can be given for the introduction and use of more appropriate technology through changes in the corporate tax system. Training expenses which are reported at cost might be reported at cost plus 50 percent for those training activities meeting government objectives. The import, testing and adaptation of technology could also be given favorable tax treatment. The revenue loss to the government would be less than the costs if the government were to finance similar training activities.

The government tax revenue derived from the profits of commercial and institutional enterprises is quite small, i.e.:

1975/76	YR 10.4 million (3 percent of revenues)
1976/77	YR 12.8 million (2 percent of revenues)

4.5 Grants in Aid to Importers

To effect significant changes in technology, the use of stronger inducements may be necessary, including "grants in aid." Well operated private repair shops (both mobile and stationary) should become widespread throughout rural areas and reach a high percentage of villages. It is in the interest of the government to assist the private sector to establish such facilities. In some countries, vocational training would be considered the responsibility of government, but in Yemen this can be accomplished at lower cost through private firms.

Given financial support, certain of the larger importers could acquire the managerial and technical skill to:

- establish and operate a wide variety of repair shops;
- provide training for machinery operators; and
- modify the designs of imported equipment to suit Yemeni conditions.

4.6 Service Contracts

Grants to finance specific activities could be supplemented by asking commercial enterprises to carry out an activity over a period of time under contract with the government. For example, a private foreign or local engineering company might be requested to assist in the design and installation of systems for village electric power, solid waste disposal, water systems, and sanitation.

4.7 General Expression of Intent

Accompanying the introduction of policies such as the above should be a strong, well publicized expression of Government intent to the effect that steps are being taken to strengthen the Yemeni economy by a program to minimize the import of equipment considered unsuitable for Yemeni conditions, to improve machinery maintenance and repair services, to upgrade the vocational skills necessary to maintain essential equipment and to improve health and housing by the establishment of higher standards.

The expression of policy could also include the announcement of Government support for a specific project such as that described in Chapter 5 of this report.

CHAPTER 5

RECOMMENDED FUNCTIONS AND ORGANIZATION FOR PROJECT IMPLEMENTATION

5.1 The Project Functions

The first action to be taken would be to select a consulting firm to supply backstopping services and to engage four long-term technicians to work for three years with Yemeni counterparts. The technicians and their counterparts would develop an institution tentatively called the Yemen Appropriate Rural Technology Authorty (YARTA).

The YARTA would carry out the following work objectives, described as tasks:

Task 1 - Literature Search

YARTA would consult with and search the literature of organizations already engaged in the study and promotion of appropriate technology. Emphasis would be placed on the identification of technologies that have proved successful in countries that are arid, food-deficit, mountainous, and which have a tradition of isolating and protecting women. Labor-saving technologies should be emphasized. The search for technologies would be limited to the following three areas:

A. Agricultural production and marketing (i.e., haulage from farm to market).

B. Home and health improvements.

C. Agricultural product processing and the repair of equipment used in rural areas.

The organizations to be approached would consist of (a) non-commercial organizations with a substantial body of experience in appropriate technologies, and (b) commercial organizations.

Task 1-A - Non-Commercial Organizations

The 24 non-commercial organizations to be approached would include the following:

(1) A. T. International, Washington, D.C.
(2) Brace Memorial Research Institute of McGill University
(3) East-West Center, Technology Development Institute, Honolulu
(4) Georgia Institute of Technology
(5) GRET (Groupe de Recherche sur les Techniques Rurales
(6) Intermediate Technology Group, London

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(7) International Development Institute of Indiana University
(8) International Rice Research Institute (Agricultural Engineering Department) at Los Banos, Philippines
(9) Massachusetts Institute of Technology
(10) National Research Council, Board of Science and Technology for International Development
(11) OECD Development Centre, Paris
(12) Office of Appropriate Rural Technology (a part of the Government R & D Agency ITINTEC), Lima, Peru
(13) The Peace Corps
(14) Technical Assistance Information Clearing House, New York City
(15) The Technology Consultancy Center, University of Kumasi, Ghana
(16) TOOL of Eindhoven, The Netherlands
(17) TRANET (Transitional Network for Appropriate Alternative Technology, Alexandria, Virginia
(18) Tropical Products Institute, London
(19) Volunteers in Asia, Stanford, California
(20) Volunteers in Technical Assistance (VITA), Mt. Rainier, Md.
(21) Appropriate Technology Cell, Ministry of Commerce and Industry, Islamabad, Pakistan
(22) Denver Research Institute, Denver Colorado
(23) Overseas Technical Cooperation Agency (OTCA), Ministry of Foreign Affairs, Tokyo, Japan
(24) University of Ibadan, Ibadan, Nigeria

Annex F at the back of this report shows the addresses of most of the above.

Included in the list of 24 non-commercial organizations are three that are engaged in the testing and distribution of appropriate technologies and therefore are engaged in the same kind of work envisaged for the YARTA. These three are: the Appropriate Technology Cell of the Ministry of Commerce and Industry in Pakistan; the Technology Consultancy Center in Ghana; and the Office of Appropriate Technology in the Peruvian R & D agency, ITINTEC (see AID Project Paper for Peru, No. 527-0162 LAD/DR, 1978, August). Of the three, two are in part financed by AID funds, namely the organizations in Pakistan and Peru. There are other organizations as well especially in India, and a more complete listing should be prepared as the project gains momentum.

Task 1-B - Commercial Organizations

Under Task 1-B, YARTA, with the help of the consultants' home office, would communicate with commercial organizations producing appropriate equipment in the industrialized countries (U.S., Europe and Japan). Many of these commercial organizations would be identified under Task 1-A, but others would have to be identified with the help of the Intermediate Technology Group in London (Mr. George McRobie) and one consulting firm in Tokyo (such as Fuji-Citibank Consulting Co., Business Intercommunications, Inc. or Pacific Projects, Ltd.)

In Europe and the United States, contact would be made with manufacturers of tools, camping equipment, small capacity engines with attachments, windmills, pumps, tractors, plows, well-drilling equipment, small capacity generators, compressors, special purpose vehicles for hauling produce, threshers, grain mills, combines and winnowers, solar cookers and heaters, and surgical instruments.

In Japan, there are two firms that have specialized for many years in subcontracting with manufacturers to produce appropriate technology equipment for Southeast Asian countries.

Throughout Tasks 1-A and 1-B, technologies would be classified in accordance with the International Standard Industrial Classification (ISIC) described in United Nations Statistical Papers, Series M, No. 4, Rev. 2, Add 1, Sales No. E. 71. XVII. 8, 1971. (The ISIC system classifies economic activities, as opposed to the SITC which classifies products or commodities.)

Task 2 - Establishment of R & D Laboratory in Sanaa

The YARTA would establish in Sanaa a testing laboratory where samples would be tested, modifications made to suit Yemeni conditions, and prototypes made. This would be organized by one of the long term staff members (Vocational Training and R & D Adviser) whose functions are described in greater detail later in this Chapter.

Task 3 - Introduction of Government Policies

Discussions would take place with the Government focussing on the Ministry of Economy for the purpose of introducing policies such as those discussed in Chapter 4 to assure the prompt introduction of appropriate technologies and the improvement of maintenance and repair services on the part of the importing community (i.e., major importers of machinery listed in Annex A).

Task 4 - Dialogue with Importers

YARTA would enter into a series of continuing discussions with major importers in Yemen such as those listed in Annex A to this report. The technologies that consist of specific types of equipment would be discussed with the importers and efforts made to persuade them to bring in samples and conduct field tests in cooperation with YARTA's own R & D laboratory. The discussions and testing would be continuous and would have as their objective the introduction to Yemen of specific technologies that would improve (a) agricultural production and the transport of farm produce to markets; (b) home and health; (c) the processing of agricultural products and the repair and maintenance of equipment used in agricultural areas.

A review would be made of the adequacy of the product support programs of the major importers and maximum advantage would be taken of policy decisions taken by the Government mentioned in Task 3 above.

In the case of equipment that appears promising for Yemeni conditions, arrangements would be made with the importers to send technical staff overseas to work with manufacturers in the modification or development of equipment uniquely adapted to Yemeni conditions. The cost of such travel would be borne on a 50-50 basis with the project paying for half the costs and the Yemeni importer paying for the balance. Under the provisions costed out in Chapter 6, a total of 20 participants would be sent abroad over a three-year period (see also Annex H, Schedule VIII).

Task 5 - Dialogue with Other Donor Groups

There are several donor groups mentioned in Chapter 2 (Exhibit 2.17-B) that can be helpful in the field testing and evaluation of equipment. These include the U.S. Peace Corps, the Yemen-British Agricultural Engineering Project, the Federal Republic of Germany project at Amran, the Dutch project at Rada (agronomy and feeder road construction), the Catholic Relief Service, and several USAID projects in rural development, water supply, poultry, horticulture, and sorghum and millet improvement (Projects Nos. 019, 044, 045, 030, and 024).

Task 6 - Dialogue with Yemeni Groups

There will be a need to maintain close ties with important Yemeni groups that can help in the identification of desired technologies and in the field testing and evaluation. These are listed in Chapter 2 (Exhibit 2.17-B) and include the Confederation of Yemeni Development Associations (CYDA), the Ministry of Agriculture, the Agricultural Credit Bank, the Ministry of Education's Womens Affairs Department, the Ministry of Information (for radio and TV coverage of publicity for

Task 7 - Distribution of Technologies and Product Support

The leading importers of equipment have developed generally adequate and some excellent channels of internal distribution for the products they import. These channels should be used to make sure that the technologies found suitable under the earlier tasks are in fact being distributed to users.

The same importers would be encouraged (by means of policies outlined in Chapter 4) and by possible invocation of the provisions of the law governing imports (Annex E) to establish an adequate system of product support and to maintain spare parts inventories suitably located in the agricultural hinterlands where 80 percent of the Yemeni populace reside. This would help to ensure the full utilization of equipment purchased by Yemeni consumers (about half the tractors in Yemen are reportedly idle).

Task 8 - Achieving Project Performance Goals

The measure of YARTA's success will be the number of new technologies such as those listed in Chapter 3 (Section 3.6) that are introduced to a substantial number of users in Yemen. Goals, for example, could be set as follows:

A.	Agriculture and marketing	15 technologies
B.	Home and health improvements	10 technologies
C.	Agricultural product processing and repair.	10 technologies
	Total in three years	35 technologies

The introduction of technologies would mean the completion of the following processing steps: (a) identification of technologies as in Tasks 1-A and 1-B; (b) screening to determine those technologies that are most appropriate for Yemen as in Tasks 1-A and 1-B; (c) laboratory testing as in Task 2; (d) field testing as in Tasks 4, 5, and 6; and (e) making sure that internal distribution channels were effective in selling the technologies to users and in maintaining equipment as in Task 7.

5.2 Comments on Tasks

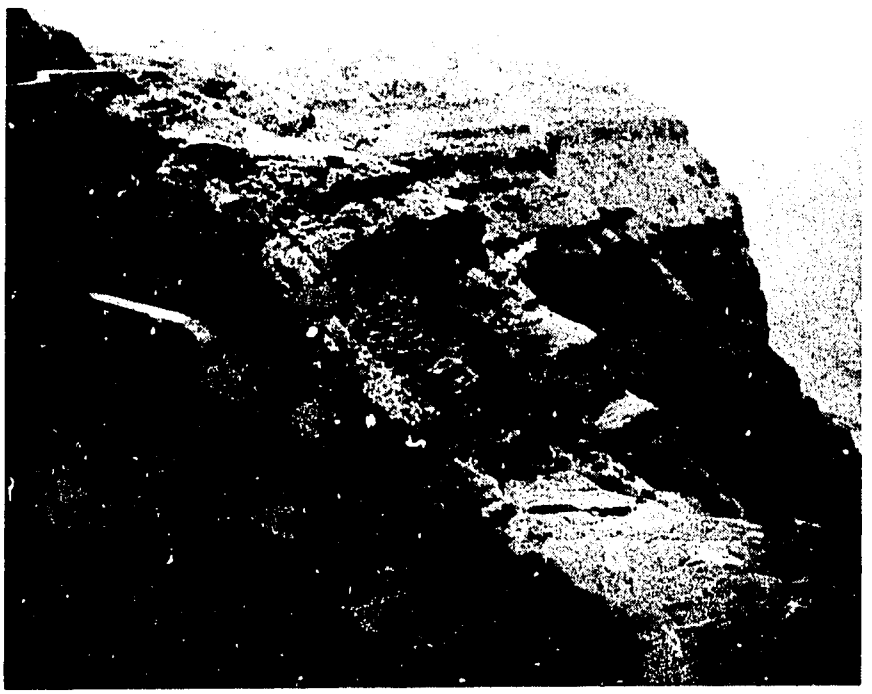
The "domestic" technologies involving the home and health in rural areas under Tasks 5 and 6 would be the most difficult to introduce. This would require cooperation with home builders, community leaders, and women who have a voice in community affairs and the media, especially radio and TV.

The effort to introduce domestic technologies would hopefully result in such changes as a reduction of wasteful wood burning for cooking, greater use of solar heat, improved sanitation in the home, more exposure to sunlight, and better and more sanitary obstetrical equipment.

Throughout the three-year duration of the project, the expatriate personnel (see below) would work with Yemeni counterparts with the goal of training them to take over when the project is terminated.

In cases where technologies were not understood or where prototype designs had to be planned for uniquely Yemeni situations, the project would finance half the costs of sending participants overseas, as mentioned under Task 4. The other half should be financed by the manufacturers' representatives in Yemen in cases involving off-the-shelf technologies that they might want to test and ultimately sell. In the case of participants concerned with home and health technologies, the costs of the participatnts might best be borne by the project.

The road from Sanaa via Ibb to Taiz was built by AID but was not paved. The West German bilateral aid program financed the asphalt paving so that beginning in 1976, all-weather travel became possible. This scene shows a segment of the road at about 3,000 meters. Agricultural terraces can be seen in the center and lower right part of this picture.



A mountain river valley (wadi) just above the Tihama coastal plain near the road from Sanaa to Hodeida. Dry most of the year, this river becomes a torrent in the "big" rainy season of July-August and covers much of the valley surface; during the "small" rainy season of March-May, there is somewhat less flooding. (See Annex B-4 for rainfall data.)

In the case of all participants, the resident technicians through their home office would arrange the itinerary and schedule appointments in advance. In Annex H of this report, a budget is suggested for "Home Office Support;" this budget could include funds for travel to Taiwan, Korea, the Philippines, Japan, and Pakistan to accompany participants seeking technical data.

5.3 Alternative Forms of Organization to Carry Out the Project

The recommendations made here to establish the YARTA has been the result of our analysis of three alternative patterns for introducing appropriate technology.

One alternative is to wait and see if appropriate technology develops spontaneously. Such a course of action would require no organization and could be left entirely in private hands.

A second alternative is to have a program staffed and managed by the Government. A third alternative falls between the first two. There are certain things that the Government can best do and there are certain things that the private sector can best handle. Our comments on these three alternatives follow:

5.3.1 The Program Entirely in Private Hands

To the extent that an appropriate technology program now exists, it is in private hands. For the most part, it is dominated by manufacturers' representatives who seek to sell imported products that are most popular. The extent to which spare parts and servicing are provided is largely decided by these importers, and in general, product support programs are not reaching the rural hinterlands. (There are some exceptions, in the next paragraph.)

The Yemen Arab Republic has approved legislation, however, that requires importers to provide spare parts equal in value to 20 percent of the machinery they import and to provide "a suitable workshop" for repairing the products imported. (Law No. 23, August 20, 1975; See Annex E.) However, the product support programs of the Yemeni importers are of uneven quality. We have observed that the representatives in Yemen of Caterpillar Tractor, Volvo, and Yanmar Diesel operate both stationary and mobile workshops. Among the users interviewed, there was a consensus that Yanmar and Volvo product support programs were excellent.

However, it is doubtful that these companies would be interested in technologies or products outside their own field of interest.

There are other private organizations that might eventually bring about or carry out an appropriate technology program. We refer here to such organizations as CYDA and the Local Development Associations, rural cooperatives, or the Chamber of Industries. These and other private organizations are and can be useful in different ways. All of them, however, lack experienced technicians, and they lack financing to do both the technical and promotional work that is needed.

Our conclusion is that if the program were left entirely in private hands, it would merely represent a continuation of the present situation. It can be argued that eventually the problems will correct themselves. The Yemeni people will discover what technologies work and what are appropriate. Some importers will help, and demonstration projects by foreign donors will also help the process along.

But the process will take years and the waste will be enormous because the Yemeni consumer sometimes buys what is inappropriate and remains uninformed about the technologies that have been developed elsewhere in the world. Equally serious is the ubiquitous idle equipment in Yemen and the slow pace at which home and health improvements are moving.

5.3.2 The Program in Government Hands

Theoretically, the Government could take over the program of importing off-the-shelf technologies found suitable for Yemen and could organize and support a program for promoting such technologies. However, such an alternative would be inconsistent with Government policies and would fail to take advantage of the vitality and potential contribution of the private sector in the dissemination of appropriate technologies. The YARG lacks the trained personnel to identify, test and distribute technologies. Instead, it must rely heavily on private importers (as it does now). The extent to which it guides the importing community depends largely on the availability of experienced staff, now in short supply.

The YARG does not have the staff to do the technical work, nor the staff to run a promotional program to acquaint the Yemeni consumer with technologies. In other words, we believe there is no way for YARG to run a suitable technology program all by itself.

5.3.3 The Program as a Combined Government-Private Effort

If the YARG works with existing importers and with other private organizations, then the program we recommend has a good chance of working. Some expatriate technicians are needed at first to evaluate technologies, promote acceptance of proven technologies and to train Yemeni employees and counterparts. Such technicians, in fact, are needed to run the "program" in its initial stages and until a corps of Yemeni personnel can take over.

To us, it seems logical that these outside technicians would form the core of a new, small organization located in the Government, which we are tentatively calling YARTA (see above). But that organization would work with and through importers. It would work with and through concerned private organizations such as the LDA's, cooperatives, as well as private businesses or village leaders. It would also cooperate with and assist Government technicians located in the various ministries concerned with economic development, health, and women's affairs, and with the public and private banks. In other words, the YARTA may be administratively attached to the Government, but it would work largely with and through the existing private structure.

5.4 Administrative Location and Organizational Factors

The approach we recommend in creating YARTA is as follows:

5.4.1 Administrative Location

We have considered several ministries with which the YARTA might be associated. In examining these alternatives, we have kept in mind that theprogram we recommend covers three program areas (see Chapter 3, Section3.4). Nor does it involve solely importation of samples or just planning. To some extent, it involves all of these activities but principally, it involves economic and technical development and home and health betterment. Our conclusion is that YARTA should be affiliated with the Ministry of Economy which has a broad range of interests in the development field and would be compatible with YARTA's purpose.

5.4.2 Form of Organization for YARTA

We suggest that the organization be an independent body or "authority" but affilitated with a ministry, preferably the Ministry of Economy, with its own budget, and that staffing of counterparts not be handicapped by the Government salary structure.

The latter point is particularly important because to function effectively, YARTA must be able to pay its secretarial and professional employees at a commercial rate in order to attract and hold them. We want to avoid the temporary assignment and then recall of counterparts by ministries. The professional Yemeni staff should be the best that can be recruited, should be pledged for an agreed period of time, and should be paid by the Authority.

In addition, we recommend that the Authority be located in a building separate from the Ministry with which it is affiliated, pay its own rent, provide its own furniture, furnishings, supplies, cars, secretarial and clerical staff, and maintain its own books. There is precedent

for establishing independent organizations associated with a ministry. For example, the Yemen Oil and Mineral Corporation and the Water and Sewerage Authority. Both are semi-autonomous.

5.4.3 Non-operational Nature of YARTA

Basically, the Yemen Appropriate Rural Technology Authority would not be operational but would arrange for other groups to take most of the action, e.g., the bilateral donors, Peace Corps, the ICA, importers, and the University of Sanaa. On technical problems (e.g., modifying equipment or machinery), it would try to work through existing organizations and programs, as well as through importers, but where necessary, it would work directly with its R & D laboratory to adapt promising technologies if nobody else will.

5.4.4 Incentives, Regulations and Promotion

The role of the importers is critical to the success of this program. To assure their cooperation, we suggest incentives for importers, and a limited degree of regulation. We think that incentives are likely to be more effective than regulatory measures although some of both may be needed.

Here are some suggested incentives that YARTA might attempt:

(1) Issue an official "approval" of technologies (hardware) brought into and tested in Yemen by YARTA. Approval of technologies already being sold should be avoided to prevent abuses.

(2) By working directly with importers, persuade them of the profitability of handling recommended technologies ("approved" products), and of providing spare parts and servicing.

(3) Work with appropriate ministries to reduce duties or to make tax concessions to importers bringing in and servicing "approved" products. (See Chapter 4.)

(4) Recommend to financing institutions that they give priority in lending for projects that use "approved" technologies.

(5) Reduce the customs duty on household appliances from 20 percent to 35 percent down to the 10 percent level, applicable to tractors. (This would help women work more efficiently at home.)

Here are regulatory measures that might be taken if needed to assure importer cooperation:

(1) As authorized by law (see Annex E), set up a system of spot-checking to identify the failure to provide spare parts, or to service and train adequately. Report such activities to the ministries involved in import licensing.

(2) While the ministries may not want to revoke licenses, they could approach importers, and YARTA could consider giving adverse publicity to specific cases where injury to consumers is obvious.

(3) As a last resort, duties could be raised or import quotas established. Such extreme action could be avoided in almost all cases.

There is a need for a promotional program to convince the Yemeni consumer of the following:

a. That it makes sense for them and for the nation to buy or to invest in appropriate technologies.

b. That it is better to spend money on approved products than to buy consumer goods or to horde.

c. That "appropriate" means "practical" for conditions in which they live. That they should insist on "appropriateness."

d. That they should insist on spare parts and adequate training and servicing, and not buy until guaranteed by the seller; they should complain loudly through their local organizations or directly to YARTA if satisfaction is not forhtcoming.

The mechanics of the promotional program will have to be left to the technicians in this field assigned to the YARTA. Certainly, all media should be considered (especially radio and TV), widespread distribution of brochures (largely graphics and cartoons), packaged slide-sound track shows or movies (portable equipment in both cases), posters and billboards. The material to be promoted (visual, written, oral) must be designed to generate positive Yemeni responses; and the program must be sustained, not intermittant. Distribution and use of much of this material should be made through LDA's, cooperatives, government agencies, the political structure (sheikhs), importers, and the traditional communications (story tellers, town crier).

5.5 Staffing of YARTA

We suggest a technician staff and their functions as follows:

5.5.1 Project Director -- Three-Year Assignment

a. Responsible for assuring project performance as measured by quantifiable criteria such as (a) number of technologies identified, (b) number field tested and approved, (c) number sold or otherwise accepted.

b. Monitors project finances to make sure project is on budget, on target, and on schedule.

c. Maintains liaison with YARG agencies to assure effective counterpart staffing and to request policy action (see Chapter 4) if necessary to encourage the importation and use of approved technologies.

d. Maintains contacts with business community (including banks) and with donor agencies to enlist support in importing, testing, demonstrating, and financing of new technologies.

e. Works with on-going related USAID projects such as poultry, sorghum, small water projects, and rural development (Project Nos. 019, 024, 030, 044, 045).

f. Working through Engineering Advisor (see below), manages activities of technicians within and outside YARTA, evaluates their findings, and elicits objective appraisals of technologies as promptly as possible.

g. Should contact media and organize publicity for YARTA.

h. He could be recruited from Yemeni migrant communities in Dearborn, Michigan; Los Angeles or New York. (Call American-Arab-Yemen Benevolent Society, Detroit, Michigan, telephone 313/841-6040 or 313/843-1698.) Should have business administration degree, business and fund raising or other promotional experience, and should be skilled in making presentations with slides, flip charts, blackboards.

i. Responsible for recruiting local staff and maintaining counterpart relations.

5.5.2 Agricultural Engineering Advisor -- Three-Year Assignment

a. Responsible for day-to-day contact with technicians on staffs of importers and donor agencies (e.g., Peace Corps, German, Dutch, British groups).

b. Makes final YARTA technical recommendations to Director and recommends prototypes and samples to be imported (Annex H, Schedule IX).

c. Evaluates sales literature of overseas manufacturers, discusses machinery specifications with representatives of manufacturers, and discusses machine performance with users.

d. Directs and reports on field testing of equipment both within and outside YARTA.

e. Works with Yemeni manufacturers (e.g., foundries, plastic product companies, truck and trailer body manufacturers, sheet metal shops, and cement product companies) to improve product quality and persuade them to make appropriate technology products. (See Annex C for list of manufacturers.)

f. Works with machinery importers to make sure they provide adequate spare parts, service and operator training. Organizes training programs that cut across brand lines (i.e., products for which no importer has sole responsibility) with help of donor agencies where possible.

g. Recommends participant programs to study, select, adapt, make prototypes overseas. (See Annex H, Schedule VIII, for participants.)

h. Is on call to trouble-shoot regarding (1) machinery malfunctions, (2) machinery selection decisions (e.g., herbicide sprayers, tractors, plows, trailers, mills, generators), and (3) importers negligence in supplying parts, service or training.

i. Recommends TDY assignments to Director. (See Annex H, Schedule II.)

j. Should have degree in agricultural mechanization and know milling, threshing, combining, soil preparation, fertilizers, pesticides, herbicides, fungicides, irrigation, pumping, and on-farm water distribution techniques.

5.5.3 Health, Education and Home Economics Advisor -- Three-Year Assignment

a. She should select and test (or have tested) home appliances and demonstrate same to Yemeni women through arrangements with LDA's, individual sheikhs, or donor agencies.

b. In cooperation with Engineering Advisor, plan simple home improvements, such as better kitchens, stoves, ovens, exhaust fans, sanitary facilities, solar stoves and heating and water catchment on roofs.

c. Advise on technologies for food preparation to maximize nutritional benefits.

d. Work with importers to assure selection of proper equipment for village home use in child birth, circumcision, child feeding, and cooking for infants.

e. Conduct seminars and prepare TV and radio copy on relationship of sanitation and nutrition to disease incidence and child mortality.

f. Work with hospitals to select equipment.

g. Recommend female participants to Project Leader and recommend TDY assignments. (See Annex H, Schedules II and VIII.)

h. Should be recruited from MA graduates of health education schools such as UCLA. Should be Arabic speaker, preferably Yemeni, Egyptian, Iraqi, or Lebanese Arabic.

5.5.4 Vocational Education and R & D Manager -- Two-Year Assignment

a. Select and order equipment for the R & D laboratory in Sanaa and install equipment. (A $300,000 budget for the laboratory is proposed; see Annex H, Schedule IX, Item N.)

b. Recruit one or two local engineers to manage R & D laboratory after expatriate assignment is completed. (See Annex H, Schedule X, Item G.)

c. Cooperate with Agricultural Engineer (see 5.5.2 above) in testing of sample and prototype equipment imported. (See Annex H, Schedule IX for illustrative list of equipment.)

d. Cooperate with Agricultural Engineer in supervising field tests by YARTA personnel or by staff of importers or donor groups (i.e., British, German, Dutch, and USAID) or YARG technicians.

e. Assist Public Health and Home Economics Advisor in working with home builders and home owners to plan better kitchens, home waste disposal, water storage, and utilization of roof space.

f. Trouble-shoot in helping machinery importers to repair equipment and obtain spare parts, recommend appropriate equipment or repairs to meet specific needs, e.g., back-pack sprayers for emergency pest control, pump breakdowns, generator outages, breakdowns of grain mills, vehicles, tractors, threshers, combines, winnowers.

g. Should be experienced in repair and maintenance of wide range of farm equipment including diesel engines, small capacity generatores, pumps, and windmills.

h. Candidates may be found among instructors in midwest, southern, or west coast vocational high schools or local maintenance facilities of Caterpillar, International Harvester, John Deere, or Massey Ferguson in U.S. or Canadian agricultural regions.

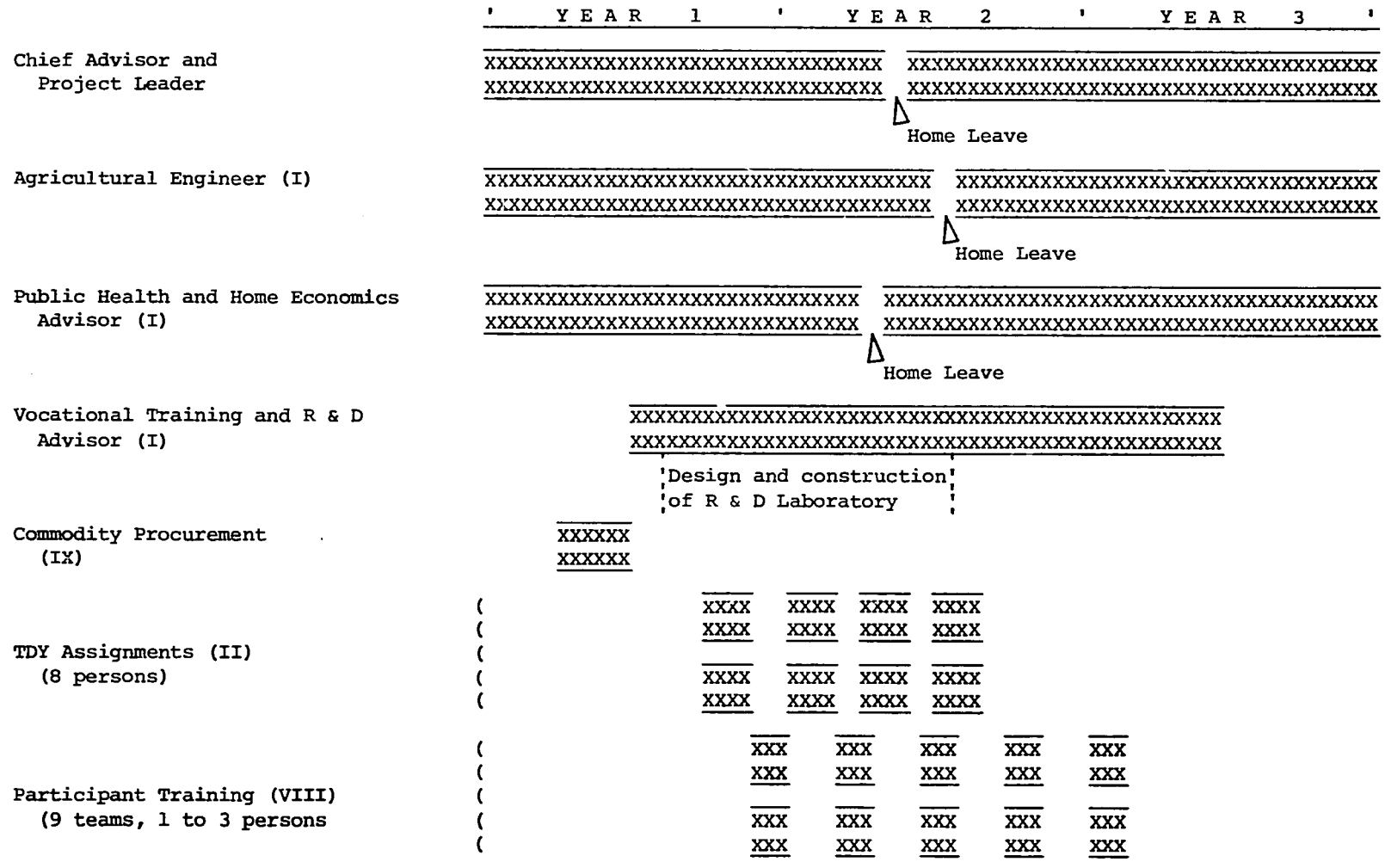
The time schedule for starting and completing major assignments is shown in Figure 5 on the next page.

Figure 5

YEMEN RURAL APPROPRIATE TECHNOLOGY PROJECT

WORK SCHEDULE

(Note: Roman numerals refer to financial schedules in Annex H of this report)



CHAPTER 6

REQUIREMENT FOR AID SUPPORT

A budget totalling $3,370 thousand for three years is proposed in Annex H at the back of this report. The budget calls for $886 thousand to cover the cost of the four-person team described at the end of the previous Chapter. ~~Eight~~ person-years of services are suggested over a 36-month period. Eleven

The assumption is made in the budget that two of the four long-term technicians would be accompanied by their families and therefore the international travel and the storage of effects, air and sea freight would be added to the above $886 thousand.

The TDY budget would finance the bringing of eight specialists over the two-year period and the participant budget would finance the sending of about 20 participants in nine teams. The commodities budget, based on the top priority items described in Chapter 3, is suggested at $265 thousand. Local currency costs which include housing, office space, Yemeni staff, and field testing come to a proposed $781 thousand. These and other budget items are shown on the next page, taken from Annex H of this report. The Roman numerals refer to Schedules in Annex H.

At this stage, the appropriate Yemeni contribution is difficult to estimate. However, interviews with importing manufacturers' representatives who import machinery indicate that they would be willing to finance half the participant costs in addition to their own programs for travel overseas. Therefore, the number of participants shown in Annex H is 20, but the AID project funds would be equivalent to the costs of only ten participants.

As the YARTA gains momentum, it would seem reasonable to expect some Yemeni support for the local currency costs budgeted at the rial equivalent of $781,000 over the three-year project life. The judgment as to what percentage of this should be borne locally ought to be explored with Yemeni counterparts after this report has been reviewed.

PROPOSED BUDGET
FOR YEMEN APPROPRIATE TECHNOLOGY PROJECT
36 Calendar Months

(Based on Annex H)

Schedule No. From Annex H	Description	Cost (000's)
I	Salaries and allowances of four long-term technicians, 18 person-years, plus overhead and fee of consulting firm selected to manage project	$ 886
II	Salaries, per diem, overhead and fee for 8 TDY technicians	88
III	International travel for technicians	30
IV	Cost of dependents of long-term technicians	14
V	Freight and storage	43
VI	Per diem for long-term technicians while traveling in Yemen and for TDY technicians	50
VII	Home office support (procurement of commodities, negotiation with suppliers of technologies, arranging participant visits, recruitment of TDY technicians, administrative support)	283
VIII	Participant training costs (50% borne by Yemeni)	45
IX	Commodities for field testing and cost of equipment for R & D laboratory	565
X	Local currency costs	781
	Subtotal	2,785
	Reserve for inflation in Year 2 (10%)	278
	Reserve for inflation in Year 3 (10%)	307
	TOTAL FOR THREE YEARS	$3,370

ANNEX A

TEN LEADING YEMENI IMPORTERS OF APPROPRIATE TECHNOLOGY
RANKED BY ESTIMATED SALES VOLUME IN 1977

	Name Head Office, Address, Telex No., Date Established		Best Selling Products (Country of Origin)	Estimated Annual Sales Volume of All Products 1977 (YR Millions)	Repair Shops and Parts Depot	Training Centers for Equipment Operators
1.	Adban Trading Co. and Subsidiaries Al Tathamon Co. and BISS Co., P.O. Box 1105, Sanaa, Telex No. 260. Founded in 1935 (leader in truck and auto sales except for Toyota vehicles)	(1)	Nissan Diesel Trucks 5-10 ton (Japan	YR 280 (includes earnings of construction subsidiary of about YR 120)	3, Sanaa, Hodeida, Taiz	Same localities
		(2)	Hino Diesel Trucks 5-10 ton (Japan)			
		(3)	Saviem Trucks (France)			
		(4)	Renault Tractors 62 HP and above (France)			
		(5)	Yanmar Diesel Pumps (Japan)			
		(6)	Steko Pumps (Cyprus			
		(7)	Neptune Pumps (Cyprus)			
		(8)	Ideal Pumps (Spain)			
		(9)	Colt Gallant (Japan)			
		(10)	Chrysler Sedan (U.S.)			
		(11)	Mitsubishi Five-Ton Trucks (Japan)			
		(12)	Subaru Sedans (Japan)			
		(13)	Eveready batteries (U.K.)			
2.	Tehama Trading Co., P.O. Box 3337, Hodeida, (Telex no. not available) Founded in 1960's	(1)	Massey Furguson 185 Tractor (U.K.)	YR 230	3, Sanaa, Hodeida, Taix plus 3 mobile work shops	None reported
		(2)	Massey Furguson 165 Tractor (U.K.)			
		(3)	Caterpillar D-4, D-6, D-8 (U.S.)			
		(4)	Massey Furguson 135 Tractor (U.K.)			
		(5)	80 to 170 HP Caterpillar Front and Loader (U.S.)			
		(6)	Dynapak 9 to 12 ton road rollers (Sweden)			
		(7)	Generator sets			
3.	Elaghil Trading Co. P.O. Box 66, Sanaa, Telex No. 2213 Founded in 1935 (leader in barley, wheat, and sorghum mills and rock drills)	(1)	Volvo Cars (Sweden	YR 220	4, Sanaa, Hodeida, Beida, Damar, plus two mobile four-wheel drive, workshops to replace filters, change oil, clean nozzles, fuel lines, adjust fuel injection pumps	Training in shovel loader operations and rock drills plus periodic training sessions if requested. Has included training as part of commercials on radio
		(2)	Volvo Trucks 5-10T (Sweden)			
		(3)	Volvo Shovel Loaders (Sweden)			
		(4)	Rock drills, Berema and Pionar (Sweden)			
		(5)	Electric Refrigerators, Westinghouse (U.S.)			
		(6)	Kerosene and Electric Refrigerators, Electrolux (Sweden)			
		(7)	Office Equipment, Facit (Sweden)			
		(8)	Copy Machines, 3-M (U.S.)			
		(9)	Pumping and Generator Sets Lombardini (Italy)			
		(10)	Small Tractors, H. Asmusen (Denmark)			

Name Head Office Address, Telex No., Date Established	Best Selling Products (Country of Origin)	Estimated Annual Sales Volume of All Products 1977 (YR Millions)	Repair Shops and Parts Depot	Training Centers for Equipment Operators
4. Awataari G. Trading and Agriculture Development Co., P.O. Box 6112207, Sanaa Telex No. 2268. Founded in 1964	(1) Universal 135 HP and above Tractor (Roumania) (2) Fendt Tractors (Fed. Rep. of Germany) (3) AGRIA Farm Equipment (Fed. Rep. of Germany) (4) Rustow and Bucyrus Rock Drills (U.K. and U.S.) (5) 1/2 ton Chrysler Trucks (France, U.K.) (6) DAF 5-10 Trucks (Netherlands) (7) Hardi Wood Working Machinery (Italy) (8) Koifor, Newton, Derby A/C Operators (U.K.) (9) Robson Agricultural Equipment (U.K.) (10) JCB Excavators-Loaders (U.K) (11) Pirelli Tires (Italy) (12) B.K.B. Generators (U.K.)	YR 200	1 workshop only located in Sanaa	Believe training limited to instruction at sales office
5. Jumaan Trading and Industrial Corp., P.O. Box 213, Sanaa, Telex No. 2255, Founded 1964 (leader in generator and motorcycle sales)	(1) Yanmar and Robin Diesel Engines 2 HP to 24 HP (Japan) (2) Suzuki, Yamaha, Honda Motorcycles (Japan) (3) Nemitas 20-80 HP Vertical Pumps (assembled in Cyprus) (4) Nemitas Concrete Mixers, about 10 HP (made in Cyprus) (5) Yanmar Diesel Generator Sets (Japan) (6) Yanmar Compressors (Japan)	YR 80	2, Sanaa, Hodeida plus 68 spare part depots	No training reported
6. Al Mohdar, Al Zobiry Street, Sanaa (no telex) Founded about 1964	(1) Fiat Tractors (Italy) (2) Fiat Generators (Italy) (3) Fiat Sedans (Italy) (4) Fiat Tractors (Italy) (5) Pumps (Japan) (6) Generators (Japan) (7) Volkswagon Cars (Fed. Rep. of Germany)	YR 50	One only, Sanaa	None reported
7. Ali Jobran Elansi, Jamal St., Taiz, Telex No. 816 for Taiz Telex No. 2304 for Sanaa Founded in 1972	(1) Mazda Sedans (Japan) (2) Mazda 1/2 ton Trucks (Japan) (3) Carraro Tractors (Italy) (4) Epason Tractors (Spain) (5) Epason Trucks (Spain) (6) Carraro Trucks (Italy)	YR 10	2, Sanaa and Taiz	None reported

	Name Head Office, Address, Telex No., Date Established		Best Selling Products (Country of Origin)	Estimated Annual Sales Volume of All Products 1977 (YR Millions)	Repair Shops and Parts Depot	Training Centers for Equipment Operators
8.	Al Sonidar Sanaa (no street address, no telex) Founded in 1972	(1) (2) (3) (4) (5)	Valpadana Tractors (Italy) Valpadona Tillers (Italy) Diesel Engines (Italy) Compare Pumps (Italy) Generators (Italy)	YR 10	2, Sanaa and Hodeida	None reported
9.	Faisal Alamri Trading Center, Sanaa, P.O. Box 79, (no telex) Founded in 1978	(1) (2) (3)	Dae Dong Single Axle Tractors and Attachments (Korea) Generators (Korea) Pumps	YR 8	None reported	None reported
10.	Allowaa Elakdar, Sanaa, P.O. Box 565 (no telex) Founded in 1976	(1) (2) (3) (4)	Yanmar Generator (Japan) Yanmar Grain Mill (Japan) Yamaha Motorcycles (Japan) Yanmar Generators	YR 5	1, in Sanaa only	None reported

ANNEX A-1

MAJOR IMPORTERS SPECIALIZING IN
NON-MACHINERY IMPORTS OR MOTOR VEHICLES

Name	Head Office	Remarks[1/]
Hazel Saeed Alam Co.	Taiz	This is the largest industrial group in Yemen with four manufacturing subsidiaries and the largest importer of non- machinery products (Rothman cigarettes, wheat, sugar, tinned goods)
Bazara Co.	Sanaa	Over 70% of the motor vehicles registered in Yemen are Toyotas, mostly four-wheel drive station wagon type and Land Cruisers (jeep type). Sales volume is difficult to estimate because an estimated 40% of Toyotas are driven into Yemen from abroad. Toyota dealters in Japan sell a diversified product mix and could probably be persuaded to sell non-vehicle appropriate technology equipment.
Al Sofary Co.	Sanaa	Mercedes Benz cars and heavy trucks (5-30 ton)
Al Thoor Co.	Sanaa	Bayern Motor Werken (BMW) Sedans
Al Kassar Co.	Sanaa	Hyundai Sedans and 1/2 ton Trucks; made in Korea
Tihama Tractor and Engineering Co.	Hodeida	Tractors and Pumps

1/ These firms are not importing appropriate technology equipment as defined in this report, but who could probably be counted on to handle new product lines and test promising items of appropriate technology.

ANNEX B-1

THE SOCIO-CULTURAL SETTING FOR APPROPRIATE TECHNOLOGY IN YEMEN

The purpose of this Annex B is to describe the setting in which appropriate technology can play a part in the modernization of Yemen. The analysis points to the conclusion that, despite the on-rush of superficial changes brought on by newly found income, Yemen still remains a "sociological Galapagos Island." Trends in the world outside were stoutly resisted until the revolution of 1962 and hardly noticed during the ensuing eight years of civil war.

The Yemeni setting is described under 11 headings below:

1. Social Organizations and Castes
2. The Status of Women
3. Land Tenure
4. Ecology
5. Nutrition
6. Health
7. Education
8. Religion

Annex B-2 - Commonly Grown Crops
Annex B-3 - Soils in Yemen
Annex B-4 - Meteorological Data

Introduction

Yemen is classified by the U.N. as one of the least developed countries. Although the site of one of the world's oldest civilizations (the ancient Kingdom of Sheba existed in Yemen as early as the tenth century B.C.), until the revolution of 1962, Yemen was kept in the middle ages--deliberately isolated from the modern world--by its theocratic rulers, the Imams. Progress was delayed after the revolution by a series of civil wars which ravaged the country for a period of eight years, 1962-1970.

Even at the emergence of the Kingdom of Sheba, the people of Yemen were sedentary cultivators, and much of Yemen today is covered by ancient terraces that are among the most sophisticated in the world. But the years since the establishment of peace have been marked by recurring droughts which have taken their toll of agriculture.

A major change has been occurring in Yemen since 1974 when the costly development programs of the neighboring oil producing states began to gather momentum. As oil revenues suddenly increased in other countries of the Arabian peninsula, there has been an increasing need for workers. About 600,000 Yemeni workers are now supplying the need

for labor. Emigrant workers have gone to other destinations as well, including the United States where some work in the auto industry and reside in Dearborn, Michigan. It is the custom of these migrants to send a large part of their wages back home to Yemen. The migration of so many males of working age has created a severe labor shortage in Yemen and those who remained at home are able to find jobs at wages now almost as high as those received by the migrants.

In keeping with its long isolation from the modern world, Yemen is almost without industrial production, and it did not take long for the manufacturers of the world to discover and exploit the new market created by the large part of the Yemeni population with money to spend and very little of domestic goods to spend it on. Imports for the year ending June 30, 1977 were valued at U.S. $1.4 billion, double the prior year figure.

At the same time, returning migrants brought with them great varieties of consumer goods from the outside world, as well as a great desire for even more consumer goods to buy. In the Tihama, one often sees a TV aerial perched on the roof of thatched, primitive houses. In the highlands, Arab stone houses without water supply and only holes in the floor for human waste often have TV and a half-ton truck parked at the door.

Despite the coming of the jet age, women are still veiled, carry heavy bundles or water jugs on their heads, and walk through unpaved streets amid the odors of human and animal excrement mixed with dust. In contrast to these conditions, the women have enough money for emigrant relatives to buy glittering and elaborate dress materials and gold ornaments to wear beneath their black outer garments and heavy veils.

Poor sanitation--of water, food, home, community--is responsible for the deplorable health statistics of Yemen, and poor sanitation is a least common denominator that links the newly prosperous rural families with the semi-nomadic former slaves who camp beside their villages. Nearly universal illiteracy, particularly for women, is another least common denominator that does not make much distinction in "levels of living" for the various groups of Yemeni society.

In terms of the quality of life, the population as a whole can be called the poorest of the poor even though in terms of money and possessions such a classification would be inaccurate. Therefore, the criterion of GNP cannot be used for classifying Yemen as among the world's poorest countries, but in terms of sanitation, nutrition, illiteracy, wasted resources, and low productivity, Yemen is among the poorest of the world's nations.

1. Social Organization and Castes

There are four bases for social organization in the Yemen Arab Republic. Status newly gained in the modern business sector has been imposed on the traditional social/political/religious system which is based on tribe, community and religion.

Although not all of the population of old Yemen was tribal, all found their place in the social system with reference to the tribal structure. Within the tribe, there are various social stata. Non-tribal groups are assigned high (Sada) or low (Akhdam) status according to their relationship with the tribes (Qabail).

In the tribal system, each of the more than 400 tribes is a member of a larger group, or tribal federation. Each tribe is divided into smaller constituents--subtribes, clans and lineages--each having been founded by a progressively closer male ancestor. At the head of each group of each organizational level of tribal society (federation, tribe, subtribe, clan, lineage), there is a sheikh, those at the head of larger groups being termed sheikh al masheikh, or "big sheikh."

Although Yemen is largely a nation of rural dwellers (almost 90 percent), the population is not scattered over the countryside; rather, the settlement pattern, adapted as it is to the necessity for defense, is one of nucleated villages--or groups of villages, ozlah, each surrounded by its farmlands. In the mountainous areas, villages may be perched atop mountain peaks, or low in the valley-- the first location chosen for purposes of defense, and both locations sited on land too infertile to be farmed.

The smallest villages may be inhabited primarily by a single lineage. The majority of the members of a somewhat larger village, or of an ozlah may belong to a single clan. The larger village may be inhabited largely by members of a single tribe, and larger towns may contain members of a few tribes. Dhamar, for example, a town of about 20,000 population, is made up of members of three tribes. Each village has a headman, aqil, and--depending on the composition and size of the village--he may also be the lineage clan or subtribal sheikh. He will probably be a rich man, from a big family. A large village may have more than one aqil; an ozlah may be under a single aqil.

The aqil serves as arbitrator and magistrate in disputes between community members.

In terms of status within the tribe, all tribesmen are theoretically equal. Smaller sheikhs are elected by all male members of the group, and they, in turn, choose the big sheikhs from among themselves. The status of the sheikh is officially that of primus inter parea. In actuality, in any group, sheikhs are selected from certain leading families, and the position has sometimes become hereditary within one family. At the same time, the authority of the sheikh is at the will of his followers; if he loses popularity, contenders may arise and the sheikh is replaced.

In Yemen today, a given community may have two sheikhs. An "old sheikh" may still be nominally in power, but where there is desire for modernization, a "young sheikh" may have arisen as the leader of the more progressive faction of the village. The young sheikh is likely to be an educated young man of one of the old sheikhly families. Equal or even above the tribes in status is the non-tribal group of Sada. The Sada who derive their high status from their descendancy from the prophets tend to be urban inhabitants and to have a higher rate of literacy than the rural tribesmen. They serve the tribes by performing the necessary role of unaffiliated intermediary and peacemakers in situations of inter-tribal conflict. They also serve as "lawyers" in drawing up contracts of various types. Due to their higher level of education, they often function as religious leaders and teachers in tribal communities.

Considerably below the tribes in status are various khadim groups--composed either of members of part African derivation, akhdam,* or of those cast out of the tribal system, khadama,** who serve the tribes by performing traditionally assigned occupations which are considered too menial for tribesmen. Examples of such traditional occupations are servants, salesmen, barbers, butchers, weavers, hotel and restaurant workers, owners of small hotels, and the town crier and messenger. An important female role performed by members of this group is that of bridal attendant. Women are also potters, but home duties are still dominant.

The cultivation of certain vegetables is also assigned to those of low rank, indicating the low status of these foods as compared to those traditionally cultivated by male farmers, namely various cereals, fruits, and qat.***

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* Many of these may also be abid, former slaves, or descendants of former slaves. Slavery was not abolished in Yemen until 1962.

** Another interpretation is that these people (also termed bani al khums) are a low class within the tribe. They are endogomous within the class but may marry between tribes.

*** A plant, the leaves of which are chewed for their stimulating (followed by narcotic) effect.

In the last few years, food habits have begun to change and the cultivation of vegetables has become highly profitable (partly because of exports to Saudi Arabia). In these changed circumstances, male farmers have begun to cultivate vegetables.

With the early 1970 entry of Yemen into the modern commercial world, some of the rurally based tribesmen are beginning to take on non-traditional, urban-oriented professions such as product wholesaling, warehouse management, dealerships for foreign manufacturers, hotel and restaurant management, and a few are becoming entrepreneurs in manufacturing, importing, and poultry raising. (See Annex C for list of manufacturing establishments.)

In other words, the acquisition of wealth in the modern system becomes a new source of increased status in the traditional system. Indeed, wealthy returning migrants, importers or leading businessmen, and persons acquiring higher education of the new type (as opposed to the traditional, or Quranic learning) now become leaders of their home village, usually through election to the board of the L.D.A.*, or even to its headship. More commonly, however, the head of the L.D.A. would be the local sheikh.

The various groups of lower social standing, whether akhdam or kadama, practice endogamy and are still restricted to certain prescribed occupations; in this sense, they can be true castes. A certain amount of occupational flexibility among these castes is beginning to appear. In villages too small to have members of each occupational group, the traditional occupations or tasks of unrepresented castes may be performed by residents of other castes.

Akhdam from the Tihama can be seen camping outside highland or midland villages where they are paid for their traditional services, such as street cleaning, refuse disposal, tooth extraction, entertaining,** farm labor, etc. In Sanaa, they are employed by the city as street

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* The Local Development Associations (L.D.A.) are said to be the outgrowth of spontaneous cooperative movements. They are represented in the government through the CYDA (Confederation of Yemeni Development Associations) through whom they channel requests for help with community development projects, such as better roads, water supplies, mosque improvement, schools, etc. LDA's are composed of men who are elected by the men of the community.

** They are paid for entertaining in the sense that villagers enjoy watching their musical or dance performances and often give gifts of cash.

cleaners. During their stay in Sanaa, they make their camp in any vacant lot, and a family may remain perhaps a half year before they move on. For celebrations, such as Id al Fitr,* a great number of akhdam join the regular camp group.

2. The Status of Women

Within any of the various Yemeni social groups there is great difference in the status of men and women; indeed, among the women of the world, the status of women in Yemen must be ranked as among the lowest.

In general, Yemeni women are occupied in the home, in water haulage and fuel collection, and in the rural areas--on the farm, where certain chores are traditionally theirs. These female chores include care of livestock, planting, weeding, harvesting the crops, and winnowing the grains. Even though traditionally performed by men, the shortage of males has begun to force women to undertake other farm tasks, such as plowing and threshing, two agricultural tasks which require physical strength.

Women residing in urban areas do not share the necessity to move about that farm work imposes on most village women. For this reason, they tend to have even less freedom than their rural sisters. They are more in seclusion in the home, and more thoroughly veiled when they step outside. Throughout Yemen, men and women participate in separate and active social lives; however, informal contact between the sexes is more frequent in the rural areas. This has an effect on marriage patterns. Married couples in cities are likely to be strangers to each other when they meet for the first time at their wedding. In the countryside, the man and woman are likely to know each other, at least by sight, and, although marriages are arranged--as they are for all traditional Yemeni--their wishes are consulted to the extent that marriage to a partner that is displeasing to the other is not forced on either man or woman. Indeed, Islamic law requires that both partners give their consent to the marriage. Although not required, marriages are frequently between cousins, particularly if they are first marriages. Since social status comes through males, a man may marry a girl of lower status and retain his family status, but a woman may not. A woman is permitted, however, to marry a man of higher status.

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* The four-day celebration marking the end of the fast of Ramadan.

Age of first marriage is very young for girls, averaging about 14 years. Their seclusion has begun even before that time, indeed, even before puberty. The men value the seclusion of their women and, in some cases, successful farmers who can afford to do so prefer that the women stay at home rather than work in the fields. There are indications that seclusion is also valued by some women. Women whose husbands have a modern attitude sometimes offer their wives a chance to drop the veil but women usually refuse to do so, citing their religious duty.

Polygamy, although allowed in accordance with Islamic tradition, is uncommon in Yemen, but serial marriages are common for both sexes, particularly for the men for whom divorce is automatically awarded after a declaration of intent or in cases where a wife dies. Death in or following childbirth is cited as being as high as 10 percent and Yemeni women characteristically face this hazard many times. Indeed, Yemen is one of the rare countries in the world today where life expectancy is lower for women than for men. Averages cited in various sources for both sexes range from 37 to 45 years.

For men of high social standing, the bride price has risen and can now be as high as 50,000 rials ($11,100) for a first-time bride. A bride who has been married before, regardless of the number of times, receives a bride price of about half that of a first bride. The bride price pays for the cost of the customary, very elaborate wedding celebration which may extend over a period of a week. Part of the remainder of the money and all the gold jewelry proffered as part of the bride price is the property of the bride and serves to support her and her young children in the event of divorce. In a divorce, children stay with the mother up to the age of seven and then move to the home of the father or his family. Many women today have in their possession substantial amounts of money--gained through bride price or through gifts from absent husbands, or inheritance (daughters in Yemeni families inherit half as much as sons in accordance with Quranic law or sharia'a). However, they cannot be said to have control over their money. A married woman must have her husband's consent before making a significant purchase as indeed she does for any non-routine activity. Women who hold money sent them by husbands working abroad do not spend freely. The money is typically held until the husband's return, unless he sends instructions as to how it is to be spent. Except in the case of gold jewelry or dress fabric, the money is usually sent through a male relative. If the husband is unavailable because of a prolonged absence abroad or death, the husband's father or his brother's consent must be obtained before making a major purchase. For a divorced or widowed woman who has returned to her father's house, her father's consent must be sought for the spending of money. Still, a divorced or widowed woman is likely to have more freedom than do her married sisters, since there is no husband to restrict her activities.

Possibly for this reason, and fortified by the possession of enough money to be financially independent, divorced and widowed women are increasingly expressing a desire to remain unmarried.

The greater freedom of action allowed widows and divorcees brings to them greater entree to educational and job opportunities which are beginning to open for women.

Apart from the money acquired through bride price, inheritance and gifts from her husband, the Yemeni woman is unlikely to handle much money in the course of her marriage; this is because husbands usually make purchases for the home, and even shop for family food in the market.

As in the spending of money, married women need their husband's permission for most activities. In Sanaa today, a married woman must produce evidence of her husband's consent before taking a certain job. Some married members of the Yemeni Women's Association in Sanaa have chosen to accept divorce rather than accede to their husband's demand that they resign from the organization.

A tragic consequence of the need for a husband's consent before taking action is that women sometimes refuse hospitalization for themselves or their children until such consent can be obtained, often too late to save a life.

Another constraint on women's seeking modern medical care, particularly in the area of gynecology and maternity, is that modesty dictates that they be examined or treated only by a female and there are almost no females trained in modern medicine or even nursing in Yemen. When a deliberate effort is made to recruit women for nurses' training, there are very few females with sufficient education to meet entry requirements and most of such females are denied paternal consent.* This is related not only to requirements for modesty, but also to the early age of marriage. The parents usually arrange a marriage for their daughter to take place well before the completion of the nurses' training course. Nevertheless, the Health Manpower Institute run by the WHO had a 50 percent female enrollment of a total of 143 students in 1975 in the three branches located in Sanaa, Hodeida and Taiz. However, the number of female students who drop out for marriage before completing the course tends to be very high.

It is said that one reason fathers refuse permission for daughters to enroll in the nurses' training course is that nurses move away from home in order to find jobs in the nation's few hospitals. There are

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* Almost all Yemeni nurses are male.

yield does increase by 50 percent. (At the German agricultural project northeast of Sanaa, irrigation has resulted in a doubling of wheat production. However, irrigation necessitates extra work, and extra expenditure for herbicides, for example, and for labor.)

Insofar as some remittances from migrants may go into irrigation of rented land, the sharecropper may be worse off as a result of agricultural development. The same may be true of small farmers who may be induced to sell their land to a returned migrant who often invests his money in land. On the other hand, land prices have risen so high in response to the desire for investing in land, that the small farmer may gain by selling his land and reinvesting the money obtained through the sale. In any case, the investment of money of wealthy migrants in land, while it serves to reinforce the pattern of large holdings by a small elite, is a mechanism for distributing the wealth earned through migration.

The various types of land tenure, and the frequency of each, obtaining throughout Yemen in 1965 are cited as follows in a 1973 FAO study (see Annex D, item 63):

(1) privately owned large landholdings (Iqta), leased for a share of the crop, constitutes 60-70 percent of all arable land;

(2) land held by religious groups (waqf) constitutes 15-20 percent;

(3) privately owned small farms (mukl) constitute 4-10 percent;

(4) state farms constitute 2-3 percent; and

(5) collectively owned land, such as that held by extended families (mushaa) or a village (hima), constitutes about 1-3 percent of all arable land. About 90 percent of all pasture land is collectively owned.

According to the FAO study, in the Timaha near Hodeida, sharecropping is practiced on 90 percent of the arable land of whatever form of ownership, indicating that farm ownership is more a form of investment than of occupation, and that while land ownership is a mark of high status, farming itself may be a mark of low status. In any case, some 90 percent of the Yemeni population of five and a half million are engaged in farming.

Some large landowners may not even involve themselves with the rental of their land, but instead may engage the services of a middleman for this purpose.

presently only 25 hospitals, 12 dispensaries, 13 health centers, and 75 rural health units (according to Syncrisis, 1978, p. 57; see Annex D, item 65).

In Sanaa, since the recent boom in remittances from migrants, numerous banks have opened in response to the needs of businessmen. Many of these banks have women typists who come to work veiled and usually occupy office space apart from the men employees. The same is true in government offices. There is also a special segregated work space for women workers in the Chinese-built textile factory in Sanaa. The factory also provides a day care center--the only such facility in Yemen--for the convenience of women workers. This Chinese-built and managed textile factory is often cited as an outstandingly successful effort in bringing women into gainful employment.

In the rural areas, women may work as farm hands for pay, and also may be employed in some aspects of construction work, such as carrying water, cement, mud, and gravel. In such cases, they are paid less than men doing the same work. For example, their construction jobs pay $4.44 to $5.56 (20-25 rials) per day whereas unsilled male constructions workers get over twice as much. Both also receive meals and qat as fringe benefits. Unveiled akhdam women from the Tihama may be seen working as street cleaners in Sanaa.

Women have increased their role in agriculture because of the absence of so many men from the agricultural labor force. There are about 600,000 males working abroad which is 44 percent of the male labor force above 15 years of age. The reduction of the number of men in the rural areas has caused agricultural output to decline. The official statistics (Statistical Yearbook 1976/77, p. 258) show a decline of seven percent in constant prices as between 1975/76 and the prior year. There is other evidence, such as the number of uncultivated plots and the number of terraces in need of repair.

3. Land Tenure

A commonly accepted indicator of social status in Yemen is land ownership, and in many parts of the country, land tenure still largely follows the fuedal pattern where most small farmers are sharecroppers on land rented from a larger landholder. The ordinary share arrangement is for one-quarter of the crop to be paid by the tenant to the landlord; but where ground water irrigation is provided, the landlord's share is increased to 50 percent. Clearly, if irrigation does not increase his crop yields by 50 percent, the tenant stands to lose by the improvement and if irrigated farming requires more work, he may lose even if the

4. Ecology

In general, Yemen is an arid country and only about 1,500,000 of its 20,000,000 hectares are arable. On the basis of topography as well as extent of aridity, the country can be divided into four ecological zones, each with its characteristic agricultural systems.

The 30-50-mile wide coastal plain bordering the Red Sea, known as the Tihama, is hot and dry. Some line fishing is practiced along the coast and fish are marketed, fresh, dried and smoked. (It is estimated that fish catches could be doubled with more efficient fishing equipment and that such improvement should be matched by improvements in preservation and distribution.)

Inland from the coast, most of the Tihama is desert, or near desert, exploited by herdsmen for their camel, sheep and goats.

Agriculture is limited almost entirely to the lower wadis where "spate" irrigation (i.e., flash flooding) drains off the seasonal floodwater to augment water supplied by the rains. Today, there is an increasing amount of tubewell irrigation on Tihama farms. Wadi agriculture yield sorghum, bullrush millet, pulses, and vegetables, plus sesame seeds and cotton.

The northern and central parts of the country consist of highlands with much of the mountainous areas being too steep and rocky for cultivation. Some cultivation is done on ancient terraces carved into the mountain slopes; intermountain plains also support agriculture.

Characteristic crops of the highlands are cereals (sorghum, wheat, and barley), pulses of various kinds, fennugreek seeds, grapes with qat, and irrigated "lucerne" (i.e., alfalfa). The last three are the main cash crops. Some coffee is still grown, but in greatly reduced volumes when compared with pre-1974 levels because of the increased cost of agricultural labor. Most crops in the highlands are rainfed.

Between the highlands and the Tihama is the midland region. This region has the highest rainfall and is the most fertile area of the country. Cultivation is on terraces and crops include sorghum, millet, wheat, barley, and maize, inter-cropped with peas and beans. In the lower wadis there is perennial water which allows for the cultivation of a variety of fruits and vegetables. Honey is commonly produced but is insufficient to meet domestic demand.

The eastern part of the country slopes gradually to the desert shared by Yemen and adjacent Saudi Arabia. At altitudes of about 1,000 m., some dryland sorghum, millet and pulses are produced. Below that altitude, in the desert, a few nomads earn a livelihood by camel and sheep herding.

For the country as a whole, the bulk of food crops consist of cereals and the traditional diet stems from this cropping pattern, with variations following those of crops cultivated in the different ecological zones.

5. Nutrition

No national nutrition survey has ever been carried out in Yemen, although one is planned for the near future under joint World Bank/USAID sponsorship. According to FAO food balance sheets for 1964-66, the average per capita calorie supply was under 2,000 and that of protein less than 60 grams a day, with cereals supplying about 3/4 of each. Animal products, fruits and vegetables form only small parts of the diet. Since the latter are eaten much more by the wealthy than by the poor, and more by the urban than the rural population, the bulk of the rural population suffers even more than the averages indicate from a calorie, protein, and vitamin deficiency.

In addition to cereal sources (eaten mostly in the form of breads), protein is derived largely from beans and chickpeas; sour milk also provides a small but fairly regular source of protein. Fresh fish provides a good source of protein in the Tihama, as do seeds, mainly fenugreek and some sesame. A little fish regularly reaches markets in Taiz. When fish is occasionally available in Sanaa, it is very popular. Smoked or dried fish is available in the midlands and sometimes in Sanaa, especially a small dried fish, wazif. Chicken has become more commonly eaten because imported frozen chicken is widely available. It is estimated, however, that the average rural family eats meat or chicken only about once a month. This is because the prices are high, about $1.10 to $1.78 per lb. for dressed, frozen, imported chicken, and $3.30 to $4.45 per lb. for live, local chicken.

Unlike much of the developing world, urbanization has improved the nutrition of Yemenis, since a much wider variety of foods is available in town markets than is available on subsistence farms. A food consumption sample survey conducted for the FAO by Anita Bornstein showed that immigrants residing in Sanaa consumed much more meat, eggs, vegetables, and fresh fruit than the residents of a rural village. (See Annex D, item 9.)

Bornstein suggests that while the average town dweller may be better off nutritionally than the average rural dweller, the reverse is true for the poor. In the rural areas, communities take care of their poor through mutual aid in food, while this practice is being lost in cities due to the impersonal character of urban communities. The high cost of purchased food also tends to discourage traditional food sharing.

Another increasingly common dietary change with potentially serious effects is the increasing dependence on purchased imported refined white flour to replace the traditional flour made of sorghum and whole wheat. The loss of sorghum is especially serious since it is rich in vitamin A. Except for habitual users of gat, most Yemini suffer from a shortage of leafy vegetables as a source of vitamin A.

Malnutrition seems to be common among children in the Yemen. Bornstein shows (p. 41) that among children three months to four years of age in seven villages in the Tihama, the midlands and the highlands, only 15 percent of children were nutritionally healthy, while seven percent were suffering from severe protein-calorie malnutrition (of the marasmic type). In all villages, the majority of children were classified as having mild or moderate malnutrition.

6. Health

Related to childhood malnutrition is the high rate of infant mortality in Yemen. Bornstein shows (p. 42) that, in nine Yemeni villages in the highlands, midlands, and the Tihama, the percentage of children who died under the age of 15 averaged about 47 percent of those born to village women. Seventy-six percent of these died before the age of two. Implications of these figures as to the health/nutrition situation in Yemen are more serious than they appear because they do not include stillbirths. Bornstein's figures are for the years 1971-73, so that many of the children died during years of war-time difficulty but, in the opinion of expatriate doctors interviewed for this report, infant mortality today still approaches 50 percent, among the highest in the world.

One factor contributing to the continuing high levels of infant mortality is undoubtedly the increasing dependence on infant formulas throughout Yemen. In a country with nearly 100 percent illiteracy for women and with extremely poor hygienic facilities, formula feeding of infants is extremely hazardous.

According to a review of nutrition problems in various Arab countries done in 1961 by Jaques May, Yemen showed frequent rates of night blindness; general undernourishment; rickets; and osteomalacia. Vitamin C deficiency was listed as frequent, as well as "deficiency diseases present but unspecified."

A Yemeni habit that threatens nutritional status both directly and indirectly is the chewing of qat leaves, a custom indulged in daily as part of afternoon socializing by both men and women. Qat depresses the appetite, and although the main meal of the day is eaten before the afternoon qat session, this effect undoubtedly contributes to the underweight characteristic of many Yemeni. Since children are introduced to qat by about the age of 12, qat may contribute to substandard height as well. But the most serious nutritional effect of qat is on nursing infants. The effects of qat reach the infant through the mother's milk. These effects include, in addition to the depression of appetite, constipation and insomnia, reduced lactation.

Because qat chewing by women has increased with rising incomes (money is spent for women's qat supply only if there is any left over after the men of the family have provided a full supply for themselves), it is likely that the harmful effect on babies of mothers who chew qat is increasing. The reduction of lactation induced by qat may contribute to the reduction of breast feeding in Yemen.

An indirect threat to nutritional status posed by the chewing of qat is the enormous demand it makes on family income, leaving less money to be spent on food.

7. Education

The near 100 percent illiteracy of women in Yemen has been mentioned earlier. The record is not much better for men, being somewhere near 80 percent. Although the government is attempting to increase educational opportunities, it, of necessity, has a long way to go since, as recently as the start of the civil war in 1962, the only education available in the country was provided in the mosques. Some constraints on the education of girls have been mentioned earlier in this Annex. Others include: domestic duties that keep girls at home, such as care of younger siblings, fetching water, laundering, etc.

Boys too are often kept from schooling because of work commitments. Many laborers in Yemen today are boys of 13 and younger; in government offices, boys who appear to be no more than eight or nine years old are employed as messengers, although their duties are often limited to non-school hours.

The children of the akhdam (low caste) would probably not benefit from any program to increase school attendance, due to the frequent moving of their families from place to place.

8. Religion

Almost the entire population of Yemen follows the Islamic religion and the population is divided into two major sects or schools of Islam. In the north and east, the Zeidi tribes are followers of the Shia school. In the south and west, the Shafei tribes follow the Sunni school. The importance of religion in the lives of the Yemeni people is shown by the great number of mosques which, even in poor villages, tend to be elaborate and costly structures. Communities which voice their development priorities often include repair of an old, or construction of a new mosque. L.D.A. programs often include mosque building projects. Religious leaders--the imam (prayer leader), the muezzin (announcer of the prayer times), the mullah (quranic teacher), and the qadi (religious scholar--all have high status in their communities. The general high status of the Sada as descendants of the prophet was mentioned earlier, and of the first three categories of religious leaders mentioned above, a good number are Sada. Until the revolution of 1962, Yemen was ruled by the Imam, a theocratic king, and the country is still largely ruled by shariah, or Islamic law.

A major source of revenue for the national government is the Zakat, a religious tithe of ten percent of the value of agricultural production. Since a great deal of support for L.D.A.'s comes from a share of this tax, economic and social activities are linked to religion.

It is of interest that the seclusion imposed on Yemeni women is more of Arab than religious origin; for example, Muslim women in Indonesia, Malaysia and the Philippines are neither secluded nor veiled.

The Islamic faith accords women less rights and a lower status than men. This is indicated by: (a) the inheritance rule that grants daughters less than sons; (b) the quranic injunction that women must obey their husbands; (c) divorce is much easier for men than women; (d) in case of a divorce, the children belong to the father; (e) the rule that a man can have several wives at one time if he is able to support them. (Lack of support by the husband is the most frequent reason for granting divorces to women.)

ANNEX B-2

COMMONLY GROWN CROPS IN YEMEN

	Name	Botanical Name
1.	Beans	Phaseolus species
2.	Bean root	Beta vulgaris
3.	Broccoli	Brassica oleracea v. botrytis subv cymosa
4.	Cabbage	Brassica oleracea spp.
5.	Carrots	Daucus carota
6.	Cauliflower	Brassica oleracea v. botrytis subv cauliflora
7.	Cucumbers	Cucumis sativus
8.	Eggplant	Solanum melongena
9.	Kohlrabi	Brassica napus napobrassica
10.	Leeks	Allium ampeloprasum v. porrum
11.	Lettuce	Lactuca sativa spp.
12.	Lentils	Lens culinaris Medits
13.	Watermelons	Citrullus vulgaris
14.	Onions	Allium cepa
15.	Pepper (hot & sweet)	Capsicum spp.
16.	Radish	Raphanus sativus
17.	Spinach	Spinacia oleracea
18.	Sweet potatoes	Ipomoea batatas
19.	Tomatoes	Solanum lycopersicum
20.	Potatoes	Solanum tuberosum L.
21.	Okra	Anthyllis vulneraria L.
22.	Sesame	Sesamum indicum
23.	Cowpeas	Vigna sinensis
24.	Wheat	Triticum vulgare
25.	Barley	Hordeum vulgare
26.	Maize	Zea mays
27.	Sorghum	Sorghum vulgare (bicolo)
28.	Lucerne (alfalfa)	Medicago sativa
29.	Tobacco	Nicotiana rustica, N.tabacum
30.	Cotton	Gossypium hirsutum
31.	Millet	Pennisetum typhoides
32.	Banana	Musa spp.
33.	Papaya	Carica papaya L.
34.	Parsley	Petroselinum crispum
35.	Carraway	Carum carvi L.

Other spices: Helba, Neena'a, Osfer, Tarruta, Kebzerah, Kuhtah

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Source: German technical aid group via the University of Arizona.

ANNEX B-3

SOILS IN YEMEN

The terraced land of Yemen has been carved out of the existing landscape and the soils show evidence of profile formation, indicating that they have existed undisturbed for a considerable length of time. More than half of the area in the northern and southern Uplands of Yemen is non-agricultural land, being steep, rugged, rocky and stony. The agricultural land consists of thousands of terraced fields on sloping ground, together with the inter-montane plains and smaller areas of irrigated wadi basin land.

The most widespread soils are light colored, calcareous silt loams and silty clay loams, bearing a strong resemblance to loess; they are found on gentle slopes. On steeper overall slopes, stony colluvial soils are found, brown to red-brown in color and with a high clay content; they are formed on the weathering products of the country's rock, mostly basalts and volcanic tuffs. The soils of the wadi basins contain transported elements of both the above mentioned soil formations, transformed in places by high water tables to form hydro-morphic soils.

The soils of the inter-montane plains, lying at elevations between 2,000 and 3,000 meters are highly calcareous silty loams and silty clay loams, often encompassed by extensive lava fields.

In the Tihama plains along the Red Sea, the soils are calcareous, silty and alluvial, intersected by wadi channels flanked by a narrow belt of saline soils, and, on the landward side, by stony alluvial fans at the base of the mountains.

The northern and southern Uplans of Yemen have been cropped continuously for several thousands of years and show signs of depleted soil fertility. The farmers traditionally attempted to counteract this by applying farmyard manure and ashes to the land at planting time, by crop rotation and by mixed cropping. More recently, a small volume of commercial fertilizers has entered the country, but the absence of water limits the solubility and applications are minimal.

From soil tests, it has been observed that in most of the soils, phosphorus and potash are still adequate. Most soils show high pH values between 7 and 8 (pH-KCI) and therefore acid fertilizers respond well in these calcerous soils if water is available.

Source: German technical aid group via the University of Arizona.

ANNEX B-4

METEOROLOGICAL DATA FOR SANAA

Rainfall (mm)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1963 - 68 mean	2.7	6.7	15.9	86.7	54.6	7.0	87.4	80.4	2.6	0.0	25.7	9.7	379.4
1970 - 73 mean	7.0	0.8	8.8	26.6	16.6	1.1	13.3	63.3	4.7	0.0	4.1	0.8	148.3
Temperature (°C)													**Annual**
1963 - 66 mean	12.8	15.1	16.6	16.9	18.7	20.5	20.5	19.8	18.8	15.5	14.0	11.6	16.7
1971 - 73 mean	12.8	14.7	17.6	18.0	19.8	21.3	21.7	21.2	18.3	15.1	15.0	13.0	17.4
Relative Humidity													**Annual**
1963 - 66 8.00 h	49	44	34	48	42	35	49	58	39	35	52	51	45
14.00 h	23	23	19	32	23	16	30	30	19	21	25	25	24
1971 - 73 mean	40	35	40	46	44	39	50	49	36	33	40	43	41.2

METEOROLOGICAL DATA FOR HODEIDA

Rainfall (mm)													**Total**
1963 - 66 mean	0.0	14.7	6.9	3.7	6.1	0.1	16.1	11.7	3.2	5.3	6.3	36.3	102.2
1973 (S.Gumeisha)	10.0	0.0	0.0	0.0	12.9	0.0	0.0	27.0	0.0	0.0	0.0	0.0	43.9
Temperature (°C)													**Annual**
1963 - 66 mean	24.1	25.6	26.7	29.1	30.6	33.5	32.5	32.4	31.6	29.4	29.6	24.7	28.9
1973 mean	25.0	25.4	27.1	29.8	32.2	32.7	33.8	32.6	31.8	30.1	27.5	24.6	29.4
Relative humidity													**Annual**
1963 - 66 8.00h mean	71	72	68	70	65	66	62	63	63	57	62	67	66
14.00h mean	63	62	60	60	60	57	55	58	59	52	54	57	58

METEOROLOGICAL DATA FOR TAIZ

Rainfall (mm)													**Total**
1944 - 53 mean	1.4	8.3	16.8	87.3	115.9	85.6	63.5	46.9	82.6	83.3	5.5	12.8	610.0
1963 - 68 mean	3.0	9.3	14.2	45.6	82.9	67.0	92.0	97.2	76.6	90.7	16.1	7.6	526.7
Temperature (°C)													**Annual**
1963 - 66 mean	20.5	22.3	24.4	25.1	26.4	25.3	26.6	25.9	25.2	23.9	23.5	21.0	24.3
mean max.	26.8	28.4	30.8	31.4	33.2	33.8	32.6	32.1	32.0	31.0	28.9	26.2	30.8
mean min.	15.0	16.9	18.3	14.8	20.3	20.9	21.5	20.7	19.5	18.3	17.0	14.8	18.8
Relative Humidity													**Annual**
1963 - 66 8.00h mean	46	54	46	46	43	47	74	63	54	39	46	63	52
14.00h mean	40	42	38	41	42	41	45	49	50	37	36	39	42

RAINFALL DATA FOR IBB

Rainfall (mm)													**Total**
1970	8.1	4.4	45.1	78.7	112.3	257.9	174.2	199.2	109.8	60.3	0.0	0.0	1050.0

Source: German technical aid group via the University of Arizona.

ANNEX C

MANUFACTURING PLANTS IN THE YEMEN ARAB REPUBLIC EMPLOYING TEN PERSONS OR MORE 1/ OCTOBER 1978

INDUSTRIES IN TAIZ

	Company Name (Year Founded)	Number of Employees	Product Line and Remarks
1.	Yemen Corp. for Industry and Commerce 2/ (1972)	1,200 (3 shifts)	Biscuits, i.e., sweet cookies (50 tons/24 hours)
2.	National Corp. for Sponge and Plastics 2/ (1974; PVC pipe plant 1976)	333	Polyurethane foam mattresses, pillows, cardboard boxes (for biscuits), PVC pipe
3.	Yemen Co. for Ghee and Soap 2/ (1978)	150-200	Ghee and margarine (from sunflower oil and palm oil), cans for ghee, oxygen, hydrogen
4.	Yemen Co. for Tanning 2/ (1976)	30	Processing of semi-finished hides (for export to Italy)
5.	Yemen Paint Co. (1978)	25	Emulsion and enamel paints (2,000-3,000 gals/month; will soon raise to 50,000 gals/month)
6.	Super Soft Drink (1976)	125	Bottling of Super Cola, lemon and orange flavored carbonated drinks (900 crates per hour, 8 hours per day, 1 shift; German equipment)
7.	Yemen Plastics and Shoes (1975)	90 (2 shifts of 12 hours)	Polyethylene containers and caps of various sizes, PVC shoes, crates for soft drinks, hose
8.	Yemen Plastic Mfg. Co. (1974)	200 (3 shifts)	Plastic shoes, containers
9.	Bilkuis Biscuit Co. (1973)	200 (2 shifts)	Biscuits (i.e., cookies) and confectionery, steel wool (latter was established in 1978 in spearate building)
10.	Yemen Metals Mfg. & Trading Co. (1964)	150 (1 shift)	Aluminum household goods (54 types). Machine operators are paid YR 1500 to 1700 per month. Also have small foundry
11.	Nail Plant (not complete name) (early 1970's)	(now idle)	Nails
12.	Tire Company (not exact English name)	n.a.	Only tire retread plant in Yemen

INDUSTRIES IN SANAA

1.	Yemen Textile Corp.	1,400 (1½ shifts)	Ginning, oil extraction, yarn; fabric is grey, bleached, dyed, printed; YR 600 to 1000 per month is wage for unskilled. On three shifts, 45,000 yards/day is installed capacity, but now producing 6,500 yards/day. World Bank to finance expansion.
2.	National Printing Co. (founding date not known)	50	Books, reports, posters, forms, brochures

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1/ This list is not complete but includes plants inspected or known by Rolf Carlson, Swedish Research Grantee, or by the Checchi Survey Team for Appropriate Technology.

2/ Subsidiary of the Hael Sayeed Anam Trading Corp.

	Company Name (Year Founded)	Number of Employees	Product Line and Remarks
3.	Yemen Pen Factory (1978)	17 (1 shift)	Ball point pens (use one injection moulding machine)
4.	Foam Rubber Co. (subsidiary of Hael Sayeed Anam)	100 (will start in about Dec. 1978 2 shifts)	Polyurethane foam mattresses, pillows, cushions
5.	Yemen Refreshment Industry Co.	150 (will start late 1978, 2 shifts)	Pepsi-Cola and Miranda (subsidiary of Pepsi- Cola plant in Hodeida)
6.	Construction Materials Mfg. Co. (exact English name not available)	80	Bricks for building construction will produce 112,000 bricks in 24 hours (Czech machinery)
7.	Jumaan Trading and Industrial Corp. (1976)	13 (2 shifts)	Assembly of vertical turbine Nemital pumps Cyprus. Had to abandon foundry because of proximity to oil storage. Will make 4,000 pumps per year.
8.	Technical Factory for Wood Products (not exact name)	25	Window and door frames
9.	Maam Industries Co. (1972)	45 (3 shifts)	Plastic shoes, four models, capacity is 6,720 pairs per 24 hours but working at half capacity
10.	Milk Products Co. (1978)	n.a.	Bottled milk (from powdered milk)

INDUSTRIES IN HODEIDA AND VICINITY

1.	Pepsi Cola Co.	n.a.	Bottling of Pepsi Cola
2.	Canada Dry Co.	n.a.	Bottling of cola type drink and ginger ale
3.	Yemen Petroleum Co.	n.a.	Kerosene cans, 20 liters capacity
4.	National Cigarette and Matches Co. (1971)	324	Local brands of cigarettes
5.	Oxygen Industrial Co. (correct English name not available) (1971)	n.a.	Oxygen for welding
6.	Cotton General Co.	350	Ginning of cotton, 16,000 tons/year, crushing of 1,000 tons of seed, 4,000 tons linters
7.	Bajil Cement Factory (new plant going up in Amrhan)	360	60,000 tons/year of cement produced
8.	Cotton Seed Oil Co. (not exact English name) (1970)	40	Cotton seed oil, capacity is 25 tons of seed crushed per day but only produce half capacity
9.	Cotton Yarn Spinning and Weaving Co. (1950's)	140	Cotton yarn, only a few looms operating; output is one ton of yarn per day

ANNEX D

BIBLIOGRAPHY OF RECENT PUBLICATIONS REGARDING ECONOMIC AND SOCIAL DEVELOPMENT OF THE YEMEN ARAB REPUBLIC

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18. Command Council, Chairman, LTC Ibrahim al-Hamdi, *Law No. 18 of 1975 With Respect to the Promotion and the Organization of Investment in the Yemen Arab Republic,* Sanaa, August 7, 1975.

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45. Louis Berger International, Inc., *Yemen Arab Republic Development Methodology Study*, East Orange, New Jersey, October 1977 (prepared from secondary sources for USAID-Sanna).

46. Mann, K. S., see United Nations Development Organization.

47. Miller, Paul C. and John Rogalla, *Analysis and Overview of Poultry Sub-Sector in the Yemen Arab Republic*, California Polytechnic State University, San Luis Obispo, California, early 1978 (prepared for USAID-Sanaa).

48. Ministry of Agriculture, Yemen Arab Republic, *Development of Wadi Bana, Stage I, Preliminary Report*, Sanaa, June 1977 (drafted by Bureau Central d'Etudes pour les Equipments d'Outre Mer, 15 Square Max Hymans, 75741, Paris, and Sir Alexander Gibb & Partners, Early House, 427 London Road, Reading, England).

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51. Myntti, Cynthia, *Working Paper on the Population of Yemen, No. 2, Emigration and Fertility: A Case Study From the Hujariyya*, Department of Anthropology, The London School of Economics, April 1978 (Report to USAID, Yemen).

52. Myntti, Cynthia, *Working Paper on the Population of Yemen, No. 3, Contraception in Yemen*, Department of Anthropology, The London School of Economics, April 1978 (Report to USAID, Yemen).

53. Myntti, Cynthia, *Report on Female Participation in Formal Education, Training Programs, and the Modern Economy in the Yemen Arab Republic*, Sanaa, April 1978 (Report to USAID, Yemen).

54. Netherlands, Kingdon of, Ministry of Foreign Affairs, Department of External Assistance, *RADA Integrated Rural Development Project*, Progress Report No. 1, Arnhem, the Netherlands, January 1978.

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59. Tutwiler, Richard, *A Report on Small Water Projects in Yemen*, Department of Anthropology, State University of New York at Binghamton, March 2, 1978 (prepared for USAID-Sanaa, YAR).

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61. UNICEF Eastern Africa Regional Office, *Village Technology in Eastern Africa -- A Report of a UNICEF Sponsored Regional Seminar*, Nairobi, Kenya, June 14-19, 1976 (P.O. Box 44145, Nairobi, Kenya).

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66. World Bank, The, *Yemen Arab Republic Power Distribution Project*, Washington, D.C., May 30, 1978.

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ANNEX E

EXCERPT REGARDING IMPORTS FROM
THE IMPORT AND EXPORT LAW, AUGUST 20, 1975
(LAW NO. 23, 1975)

(2) Importers must obtain permission to import any products

(3) except the following:

A. Military weapons imported by the Ministry of Defense.

B. Passengers' luggage.

C. Household effects of emigrants (returning to Yemen after residing abroad for at least one year) or foreigners who have resided in Yemen at least one year.

D. Samples.

E. Gifts.

F. Other products designated by Ministry of Economy.

(4) A. Imported products sold in the YAR must be new, not used and not reconditioned.

B. The exporting country must be the producing country.

C. The value of spare parts must be 20% of the value of imported products.

D. The importing agent must have a suitable workshop for repairing the products he sells.

E. The sellers of imported products must have an agent in YAR.

(5) The import of any product must be controlled by the Ministry of Economy or other governmental office concerned and the Ministry or other office must be informed of the sales prices and the purchase prices of imported products.

(6) The Ministry of Economy can stop the importation of any products for a certain time or fix the quantity (i.e., set quotas) or fix the prices of any products in order to:

A. Protect local manufacturers

B. Make sure products are imported from the producing country

C. Implement national economic plans.

(7) The Minister of Economy may stop imports from any country due to political factors, by order from the Council of Ministers.

(8) The Minister of Economy can ask the Council of Ministers to increase or decrease or suspend the custom duties payable by importers on imported products.

NOTE: In addition to the above excerpt, the Import and Export Law contains provisions regarding Definitions (Section 1), Exports (Section 3), Penalties and Prohibited Products (Section 4), Implementing Regulations (Section 5).

ANNEX F

INSTITUTIONS CONCERNED WITH APPROPRIATE TECHNOLOGY

A large number of institucions, private groups, and companies--in the United States and other countries--have been active in the development and application of appropriate technology. The following list is not intended to be comprehensive; it is a by-product of our information search, rather than its main focus.

A. T. International
1709 N Street, N.W.
Washington, D.C. 20006

A. T. International is a private non-profit corporation created in response to a Congressional mandate to AID for a "coordinated private effort to promote the development and dissemination of technologies appropriate for developing countries." A. T. International works with the private sector to the greatest extent possible, and builds on the experience that already exists within the development assistance community, especially private and voluntary organizations. Projects are selected in a two-step process. The preliminary review process relies on several criteria, including the use of a practical applied approach rather than the development of theoretical models; the project must also envision immediate or near-term control by an organization in the developing country. Those proposals selected become "project plans" and go through another review. Criteria used in the second phase of selection include: the incorporation of a project within an existing organization; consistency with the "economics of scale" and labor/capital proportions in the project location; and a high potential for replication, with a full explanation of the intended replication process.

A. T. International anticipates the formation of Advisory Panels. The panels will be made up of experts and organized around areas of concern to A. T. International. They will make recommendations for and assist in the development of project activities.

Brace Memorial Research Institute
MacDonald College of McGill University
Ste. Anne de Bellevue 800
Quebec HOA ICO, Canada

East-West Centre
Technology Development Institute
Honolulu, Hawaii 96822

Georgia Institute of Technology
Small Industry Development Network
Atlanta, Georgia 30332

GRET (Groupe de Recherche sur les Techniques Rurales)
34, re Dumont d'Urville
75116 Paris, France

Intermediate Technology Development Group (ITDG)
9 King Street
London WC2E 8HN, England

ITDG was founded in 1965 by Earnest F. Schumacher. It operates with volunteers who make up advisory panels in various fields. These panels then work with groups in industry and academic institutions. The panels are composed of individuals from a variety of areas using what Schumacher called the "ABC Approach"--administrators who know the "ins and outs" of dealing with government bureaucracies; businessmen; and communicators who deal with research and its dissemination.

ITDG develops small scale technologies in direct response to developing world needs. It communicates its results through the publication of manuals and leaflets as well as a journal entitled Appropriate Technology Quarterly. A publications' list from ITDG is included in the appendices.

International Development Institute
Indiana University
1005 East Tenth Street
Bloomington, Indiana 47401

International Rice Research Institute (IRRI)
P.O. Box 933
Manila, Philippines

Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

National Research Council
Board on Science and Technology for International Development
Advisory Committee on Technology Innovation
2101 Constitution Avenue, N.W.
Washington, D.C.

OECD Development Centre
94, rue Chardon-Lagache
75016 Paris, France

Peace Corps
806 Connecticut Avenue, N.W.
Washington, D.C. 20525

The Peace Corps has a sixteen-year history in the development of appropriate technologies at the village level. All Peace Corps-generated materials are reviewed in the country for which they were planned. The most relevant of these are then put into the Informatio Collection and Exchange System, which makes them accessible to worker in the development field. An annotated list of publications availabl from the Peace Corps as part of their manual and reprint series is included in the appendices attached to the report.

TOOL
P.O. Box 525
Eindhoven, the Netherlands

Technical Assistance Information Clearing House
200 Park Avenue South
New York, New York 10003

TRANET (Transitional Network for Appropriate
Alternative Technology)
7410 Vernon Square Drive
Alexandria, Virginia 22306

Tropical Products Institute
Great Britain Ministry of Overseas Development
56 Gray's Inn Road
London WC1X 8WU, England

Volunteers in Asia
Appropriate Technology Project
Box 4543
Stanford, California 94305

Volunteers in Technical Assistance (VITA)
3706 Rhode Island Avenue
Mt. Rainier, Maryland 20822

VITA has had a long experience in development assistance through use of "volunteers highly trained in specialized fields, whose careers make it possible for them to take part full time in technical assistance." VITA volunteers respond to technical requests from "...village councils, community development volunteers, farmers, owners of small businesses and from members of national and international, public and private technical assistance agencies." (Village Technology Handbook, p. VII). VITA maintains a publication program as well as an Overseas Liaison Program which encourages formation of similar technical assistance groups around the world. The appendices to this report contain a list of self-help publications available from VITA.

(Note: This Annex is an excerpt from Development Information on Appropriate Technology, Office of Development Information and Utilization, AID, May 1978.

ANNEX G

PERSONS INTERVIEWED IN CONNECTION WITH
THE RURAL APPROPRIATE TECHNOLOGY SURVEY
YEMEN ARAB REPUBLIC

August 30 - October 10, 1978

1. ABDUL, Jabar Achmed Abdul Wahab, Manager of small plant manufacturing kerosene stoves, 1 km north of Turbah, Turbah, Taiz Governorate, September 16, 1978.

2. ADHBAN, Mohamed Mubarak, President, Adhban Trading Corporation, P.O. Box 1105, Sanaa, Sanaa, September 27, 1978.

3. AFIF, Khalid, USAID, Sanaa Rural Development Assistant, Sanaa, August 31, 1978.

4. AL-KIRSHY, Abbas, Chairman, The Industrial Bank of Yemen, Sanaa, September 17, 1978.

5. ASALAMI, Ali, Manager, Banking Control Department, Central Bank of Yemen, Sanaa, September 10, 1978.

6. AZIZ, Abdul, Director of Trade, Ministry of Supply and Trade, Sanaa, September 16, 1978.

7. BAHAR, Ali, Deputy Minister of Economy, Sanaa, September 10, 1978.

8. BATARSEH, Ayoub, ILO Cooperative Advisor to Confederation of Yemeni Development Associations, Sanaa, September 11, 1978.

9. BLANK, Herbert, USAID Mission, Small Water Projects (Project 044), Sanaa, September 16, 1978.

10. BOONSTRA, John, Netherlands Integrated Rural Development Project, Rada, Beida (Dutch Volunteer), Rada, Beida, September 17, 1978.

11. BOURDON, Andre, Fisheries expert with Compagnie de Developement International et de Recherche (CIDR), Mocha, Mocha, September 12, 1978.

12. BUTCHER, R. D. D., General Manager, The Tehama Trading Company, (P.O. Box 337, Hodeida, Massey Furgueson and Caterpillar distributor), Hodeida, September 12, 1978.

13. CARAPICO, Sheila, Social Science Researcher, USAID Rural Development Division, Sanaa, August 31, 1978.

14. CARLSON, Rolf, Swedish research grantee studying industrial development in YAR, Sanaa, August 31, 1978.

15. CHOWDHRY, B. K., UNDP Financial Expert, Ministry of Economy, Sanaa, September 7, 1978.

16. ENGLEBERGER, Konrad, Agronomist, Federal Republic of Germany, Al Boun Agricultural Project (near Amran, 40 km NW of Sanaa), Al Boun, September 7, 1978.

17. FADLALAH, Dr., Physician at Hodeidah Hospital (obstetrics), Hodeidah, September 13, 1978.

18. FAREA, Abdullah Ahmed, Deputy General Manager for Foreign and Correspondent Accounts Departments, Yemen Bank for Reconstruction and Development, Sanaa, September 16, 1978.

19. GHANNAMI, A. Aziz G., Director, Aklan & Mohamed Saeed-Ghannami (agents for the Lucas Group of UK including CAV and Hartridge, P.O. Box 3176, Hodeidah), Hodeidah, September 12, 1978.

20. GHAZZI, Michael, FAO Director, Hodeidah Agricultural Extension Project, Sanaa, September 12, 1978.

21. HENDRICKS, Gerard, Netherlands Integrated Rural Development Project, Rada, Beida Governorate (Netherlands road building, plant improvement, and water supply project), September 17, 1978.

22. HENDRICKS, Lisa, Human Geographer in charge of social research, Netherlands Integrated Rural Development Project, Rada, Beida Governorate, Rada, Beida, September 17 and 18, 1978.

23. HILL, G., Yemeni/British Agricultural Engineering Project (P.O. Box 4873, Taiz), Taiz, September 14, 1978.

24. HUESMANN, Robert G., USAID Director, Sanaa, Sanaa, September 1 - October 10, 1978.

25. HUSEIN, M. S., Service Manager, Elaghil Trading Co., P.O. Box 66, Sanaa (Volvo, Lombardini, Pionjar agent), Sanaa, September 28, 1978.

26. JOE-ELLYN, Sister, Catholic Relief Service (Director, Nutrition Supervisor for Hodeidah Hospital), Hodeidah, September 13, 1978.

27. JUMAAN, Mohammad A., General Manager and Chairman, Jumaan Trading and Industrial Corporation (P.O. Box 213, Sanaa), Sanaa, September 27, 1978.

28. KASSEM, Sayed, Sheik of Beni Ghazi Village, suburb of Turbah, Beni Ghazi, September 14, 1978.

29. KEMAL, Mustapha, Director, FAO Project (plant pathology, horticulture, entomology) Center in Taiz, Taiz, September 14, 1978

30. KOENIG, Nathan, Agricultural Economist, Consultant to Checchi and Company, Washington, D.C., August, 1978.

31. LATEEF, Victor, Agency for International Development, Department of State, Near East Bureau, Office of Technical Support, Washington, D.C., August, 1978.

32. MALAVIA, Kishor, Sales Manager, Elaghil Trading Co., P.O. Box 66, Sanaa (agent for Volvo, Lombardini Pionjar), Sanaa, September 28, 1978.

33. MARABAT, Soahra, Geologist under contract with USAID, Sanaa, September 15, 1978.

34. MILLER, Penelope, Nurse at Turbah City Hospital (member of Danish volunteer group), Turbah, Taiz Governorate, September 14, 1978.

35. MOAFA, Al (Al-Moafa, Nasser), Former Ministry of Agriculture senior official, now leading farmer in Beni Husheysh (Wadi Seer), 50 km NE of Sanaa, Beni Husheysh, September 8, 1978.

36. MUTAWAKIL, Ismail, Director General of Agriculture, Ministry of Agriculture, Sanaa, September 9, 1978.

37. MYNTTI, Cynthia, Anthropologist, associated with London School of Economics and Ford Foundation, and contractor for social studies with USAID, Sanaa, Beni Ghazi village, suburb of Turbah, September 14, 1978.

38. NAZIR, Mohamed, Deputy Minister for Industry, Ministry of Economy, Sanaa, September 13, 1978.

39. NEVILLE, Mary, Deputy Director, USAID, Sanaa, Sanaa, September 25 - October 10, 1978.

40. OBERMEYER, Judith, Social Psychologist with Save the Children Foundation, Mahwit, Al Mahwit Governorate, Sanaa, September 14, 1978.

41. PASHA, Asma (Ms.), Central Planning Office, Sanaa, September 19, 1978.

42. PONASIK, Diane, AID Washington (Anthropologist), Sanaa, September 20 - October, 1978.

43. PREES, Roberta (Bobbie), U.S. Peace Corps, Associate Director for Health, Sanaa, September 22, 1978.

44. PRESTON, J. David, Manager, Citibank, N.A., Sanaa, Sanaa, August 31, 1978.

45. RACHMAN, Abdul, Secretary, Chamber of Industries, Sanaa, September 13, 1978.

46. RANSOM, David, Deputy Chief of Mission, American Embassy, Sanaa, Sanaa, September 10, 1978.

47. ROSS, Lee Ann, USAID Yemen, Economist, Sanaa, September - October, 1978.

48. RUDDOCK, Anthony, Netherlands Integrated Rural Development Project, Rada (road construction engineer), Rada, Beida, September 17, 1978.

49. SPHAER, Alice, Nutritionist, Catholic Relief Services, Maternal and Child Health Project (training female assistants), Hodeida, Sanaa, September 21, 1978.

50. STEPANEK, Joseph E., Engineering consultant to Checchi and Company and advisor on appropriate technology policy, Sanaa, September 1 - 11, 1978.

51. STICKNEY, Morgan, Acting Agriculture Development Officer, USAID, Sanaa, Sanaa, September - October, 1978.

52. SWANSON, Wallace, Agricultural Engineer, Save the Children Foundation, Mahwit, Al Mahwit Governorate (working under USAID contract), Sanaa and Taiz, September 14, 1978.

53. UPHAUS, Charles M., Agricultural Economist, USAID Sanaa, Washington, D.C. and Sanaa, August - October, 1978.

54. VARESCO, Daniel, Fulbright grantee, anthropologist (studying traditional irrigation systems in Ahjar Valley, Wadi Surdu), 22000 Boston Road, Strongsville, Ohio 44136, or Department of Anthropology, University of Pennsylvania, Philadelphia, PA 19174; Sanaa, September 28, 1978.

55. VARESCO, Najwa, National Science Foundation grantee anthropologist working in Ahjar Valley, Wadi Surdu, Sanaa, September 28, 1978.

56. VOIGT, Robert, Dr., Chief of Party, University of Arizona, Sorghum and Millet Project, USAID, Sanaa, Sanaa, October 1, 1978.

57. WILLIAMS, James, Director, Yemeni/British Agricultural Engineering Project, Taiz, September 14, 1978.

58. WIERSINGA, Rudolf, Project Director, Netherlands Integrated Rural Development Project, Rada, Beida, September 18, 1978.

59. YASIRI, Ali, Sana University (third year student), Interpreter, Al Kowla Village, Dhamar Governorate, September 16, 1978.

60. ZAID, A. Motahar Alshami, Manager, Yemen Bank for Reconstruction and Development (P.O. Box 1306, Sanaa), Sanaa, September 9, 1978.

61. ZOBAIRI, A. R. R. (Dr.), FAO Fisheries Development Advisor, Ministry of Agriculture, Sanaa, September 17, 1978.

ANNEX H

BUDGET

ESTIMATED COST OF
THREE-YEAR APPROPRIATE RURAL TECHNOLOGY PROJECT
YEMEN ARAB REPUBLIC

Schedule	Description	Cost
I	Salaries and Allowances of Long-Term Technicians, Overhead and Fee	$ 885,660
II	Salaries and Per Diem, Overhead and Fee for TDY Staff	87,610
III	International Travel for Staff	29,700
IV	Cost of Dependents of Long-Term Staff	14,144
V	Freight and Storage	43,200
VI	Per Diem for Long-Term and TDY Staff	50,112
VII	Home Office Support	283,420
VIII	Participants (50% borne by Yemeni)	45,000
IX	Commodities for Field Testing in Yemen, R & D Shop, Vehicles	565,000
X	Local Currency Costs	781,000
	Sub-Total	$2,784,846
	Reserve for Inflation in 2nd year (10%)	278,485
	Reserve for Inflation in 3rd year (10%) (10% x $3,063,331)	306,333
	Total for Three Years	$3,369,664

SCHEDULE I

SALARIES AND ALLOWANCES OF LONG-TERM TECHNICIANS, OVERHEAD AND FEE

A.	Appropriate Technology Authority (ATA) Chief Advisor and Project Leader (3 years)	$120,000
B.	Agricultural Engineer (3 years)	90,000
C.	Public Health & Home Economics Advisor (3 years)	78,000
D.	Vocational Research and Development Specialist (2 years)	60,000
E.	Three-Year Salary Cost	348,000
F.	Cost of Living Allowance for 3 years @ 10% x salary	34,800
G.	Sunday Work Allowance for 3 years @ 5% x salary	17,400
H.	Post Differential for 3 years @ 25% x salary	87,000
I.	Three-Year Cost of Allowances and Differential (F + G + H)	139,200
J.	Overhead @ 95% x salary (.95 x $348,000)	330,600
K.	Fee @ 10% x E + J (10% x $678,600)	67,860
L.	Total Three-Year Costs for Long-Term Staff (E + I + J + K)	$885,660

SCHEDULE II

SALARY, PER DIEM, OVERHEAD AND FEE FOR TDY STAFF
(Positions noted are illustrative)
(Assignments average two months each)

A.	Tractor trailer design engineer	$ 6,000
B.	Cement products design engineer	6,000
C.	Power tool engineer	6,000
D.	Automative maintenance shop planner	6,000
E.	Waste disposal installation engineer	6,000
F.	Pump maintenance engineer	6,000
G.	Housing construction design architect	6,000
H.	Audio-visual specialist for TV short programs on home management and health	6,000
I.	Total TDY Salaries	48,000
J.	Overhead @ 69% of TDY salaries (69% x $48,000)	33,120
K.	Fee @ 8% x salaries plus overhead (8% x $81,120)	6,490
L.	Total salary, overhead and fee costs of TDY personnel (I + J + K)	$87,610

SCHEDULE III

INTERNATIONAL TRAVEL FOR STAFF

A.	4 Long-Term Staff (3 x $1,500 x 2 trips) + (1 x $1,500 x 1 trip)	$10,500
B.	8 TDY Technicians @ $1,500 each	12,000
C.	Excess Baggage ($100 x 12 persons)	1,200
D.	4 Additional Trips to Supervise Prototype Production, etc.	6,000
E.	Total International Travel	$29,700

SCHEDULE IV

COSTS OF DEPENDENTS OF LONG-TERM STAFF
(Assuming two families and two children each)

A.	International Travel, 2 full fares and 4 half fares @ $1,500 and $750, respectively	$ 6,000
B.	Education Allowance for 4 children enrolled in Sanaa Elementary School	8,000
C.	Per Diem While in Travel ($6.00 x 6 persons x 4 days)	144
D.	Total Costs for Dependents	$14,144

SCHEDULE V

FREIGHT AND STORAGE COSTS FOR LONG-TERM AND TDY STAFF

A.	250 lbs. air freight per principal (4 x $1,500 both in and out of Yemen)	$ 6,000
B.	100 lbs. per dependent (6 x $600)	3,600
C.	1,500 lbs. of sea freight for 4 long-term technicians @ $2.00/lb. x 2 (return)	24,000
D.	Storage in U.S. @ $60/month x 60 months	3,600
E.	Freight on personal vehicles @ $1,500 each	6,000
F.	Total Freight and Storage Costs	$ 43,200

SCHEDULE VI

PER DIEM

A.	Per diem in-travel for 4 long-term technicians (4 persons x 4 days x $6.00 x 2 trips)	$ 192
B.	Per deim in Sanaa for TDY staff @ $66/day x 51 days in Sanaa each x 8 TDY personnel	26,928
C.	Per diem in-travel status for TDY staff @ $6.00 x 8 persons x 4 days each	192
D.	Per diem for travel in Yemen for 12 persons x 10 trips x 5 days per trip x $38 per day	22,800
E.	Total Per Diem	$ 50,112

SCHEDULE VII

HOME OFFICE SUPPORT

A.	3 person-years @ $36,000	$108,000
B.	Overhead @ 1.15 x $36,000	124,200
C.	Fee @ 10% (10% x $232,200)	23,220
D.	Travel to supervise prototype testing (12 trips in two years including per diem)	2,000
E.	Travel to Philippines, Korea, Taiwan, Japan, Pakistan	20,000
F.	Communications, Postage	6,000
G.	Total Home Office Support	$283,420

SCHEDULE VIII

PARTICIPANTS
(Study team titles are illustrative;
6 weeks @ $50/day plus travel)

A.	Small generator and village electrification (2 persons)	$ 9,000
B.	Pump design and use (1 person)	4,500
C.	Small capacity grain milling (3 persons)	13,500
D.	Tractor and attachments (2 persons)	9,000
E.	Power tool design (2 persons)	9,000
F.	Automotive workshop (3 persons)	13,500
G.	Diesel engine maintenance (2 persons)	9,000
H.	Solid and liquid waste (3 persons)	13,500
I.	Household appliance testing and use (2 persons)	9,000
J.	Total Cost Participants	90,000
K.	Less amounts provided by manufacturers' representatives in Yemen (50% of total)	45,000
L.	Cost to AID - Participants	$45,000

SCHEDULE IX

COMMODITIES FOR FIELD TESTING IN YEMEN, R & D SHOP, AND VEHICLES

A.	Pumps (3) for irrigation trials @ $3,000 each	$ 9,000
B.	Grain storage bins (6) for testing under Tihama and upland conditions @ $500 each	3,000
C.	Sorghum, barley, wheat millet threshers (6) @ $3,000 each	18,000
D.	Small tractors and attachments (5) @ $6,000 each for terrace agriculture	30,000
E.	Hand and power tools (20) @ average of $100 each	2,000
F.	Trailers (5) for tractors that cannot be locally manufactured @ $2,000 each	10,000
G.	Moulds (10) for prefabricated concrete products @ $300 each	3,000
H.	Automotive workshop equipment packages (2) (e.g., SNAP-ON TOOL CO. Packages) @ $15,000 each	30,000
I.	Grain mills (3) and sorghum stalk choppers (2) @ $4,000	20,000
J.	Household appliances, e.g., exhaust fans, solar ovens, cabinets, heaters including prototype R & D to suit Yemeni conditions	30,000
K.	Solid and liquid waste disposal equipment for village use (4)	40,000
L.	Biogas generators (2)	10,000
M.	Other equipment and R & D (e.g., herbicide and pesticide sprayers, seed drills)	20,000
N.	R & D workshop and laboratory equipment	300,000
O.	3 official vehicles (1 Land Rover, 2 Peugots 504)	40,000
P.	Total Cost Commodities	$565,000

SCHEDULE X

LOCAL CURRENCY COSTS

A.	Costs in Sanaa for housing long-term staff, 9 years rent x $24,000 each (assumes 2 people share one house for 2 years)	$216,000
B.	Costs of field testing and adapting technologies	200,000
C.	Office rent, 3 years x $24,000	72,000
D.	R & D shop and laboratory rental, 2 years	48,000
E.	POL for 3 cars for 3 years	15,000
F.	Phone and utilities	4,000
G.	4 Yemeni professionals @ $8,000/year each x 3 years	96,000
H.	Office furnishings and supplies	10,000
I.	2 local secretaries, 1 messenger-driver	20,000
J.	Cost of promotional program, including printing, mailing audio-visual aids	100,000
K.	Total Local Currency Costs	$781,000