From appropriate to sustainable: Can we identify traits that promote a technology's diffusion?

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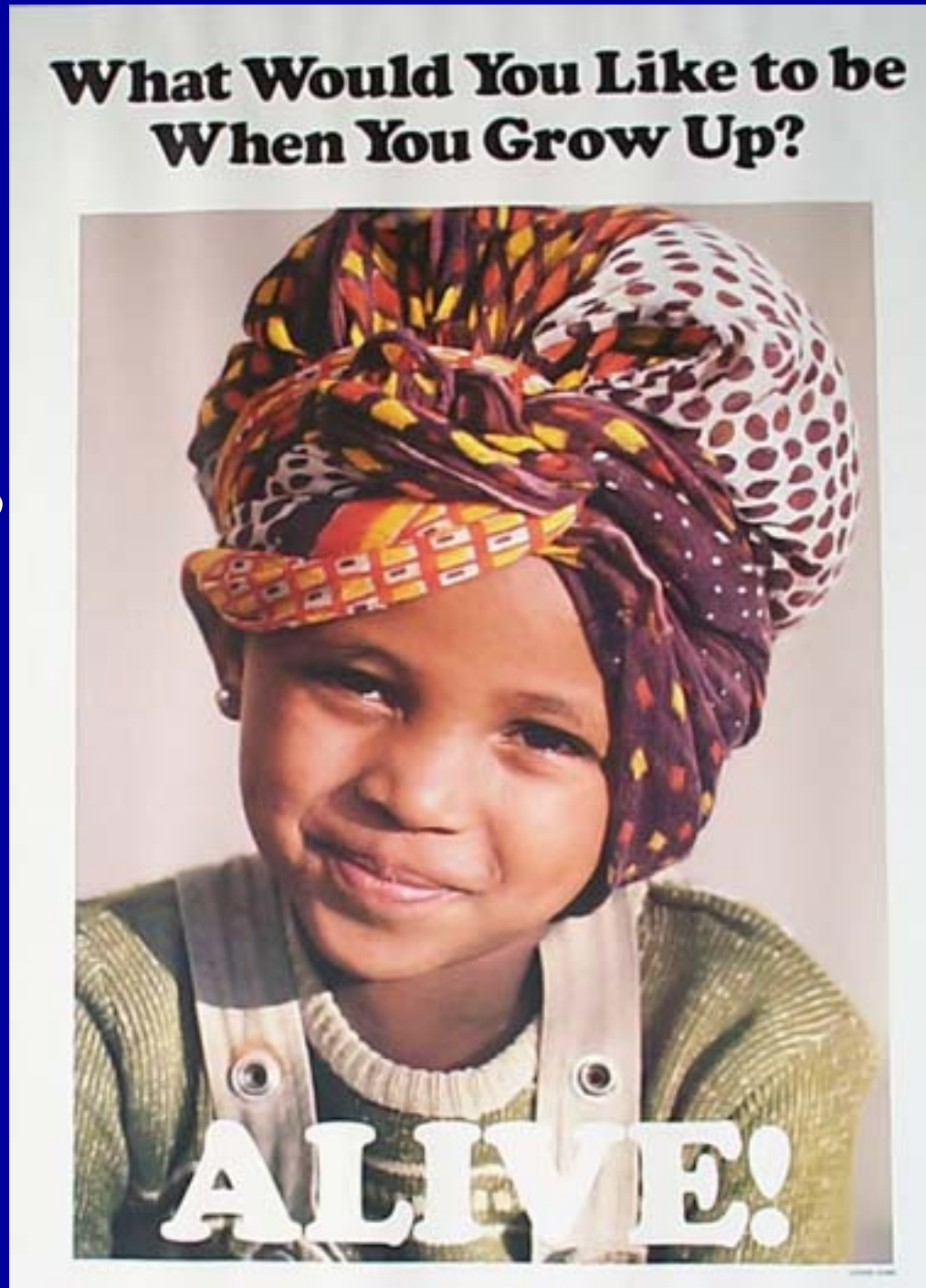


International Women and Water Conference (1998)
Kathmandu, Nepal

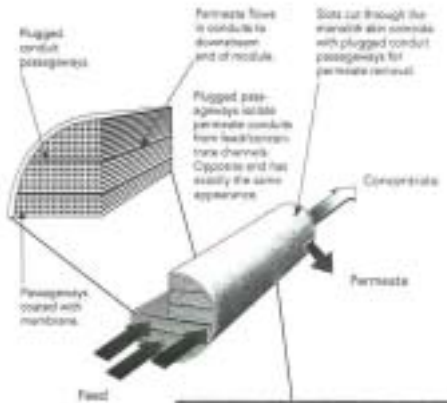
CORNING

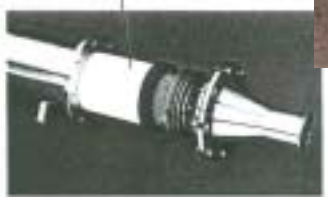
CerCor
SEPARATIONS

Liquid Crossflow Filters

CerCor Separations manufactures and sells crossflow membrane filters with pore sizes in the Microfiltration (MF) and Ultrafiltration (UF) ranges.

These filters contain a large number of approximately 2mm square parallel passageways extending from one face to the other. A CerCor patented approach modifies the monolith support by converting some of the passageways to permeate conduits. This enables the entire filter diameter to be effectively utilized.



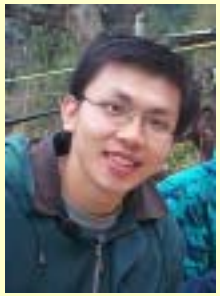


Point-of-use water treatment compliance criteria

- Effective on many types and large numbers of pathogens (for surface water)
- Should perform regardless of water fluctuations
- Must operate in appropriate pH and temperature range
- Should not make the water toxic or unpalatable
- Should be safe and easy to handle
- Any chemical concentrations should be minor
- Must provide residual protection against possible recontamination
- Units must be affordable to all
- Should be adaptable to local conditions and variations
- Specialized equipment should be produced locally
- Must be accepted by local traditions, customs, and cultural standards
- Must comply with national sanitation and pollution policies

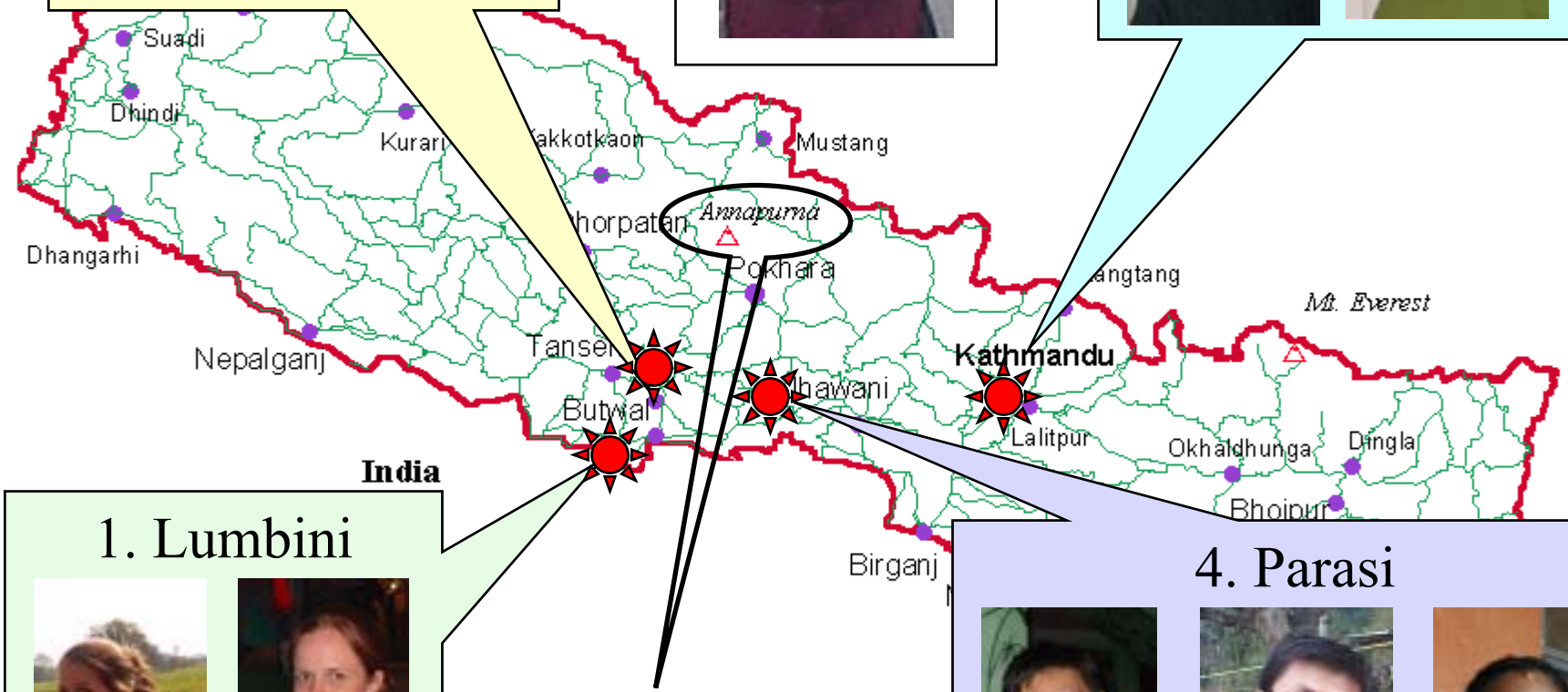
Lehr, J.H., Gass, T. E. Pettyjohn, W. A. & DeMarre, J. (1980) Domestic Water Treatment. New York: McGraw Hill.
Shultz, C. R. and D.A. Okum. (1984) Surface Water Treatment for Communities in Developing Countries. John Wiley & Sons, Inc.: New York.

2. Butwal

Everywhere

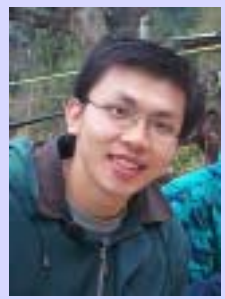
3. Kathmandu

1. Lumbini


5. Trekking

4. Parasi


Our partners in Nepal

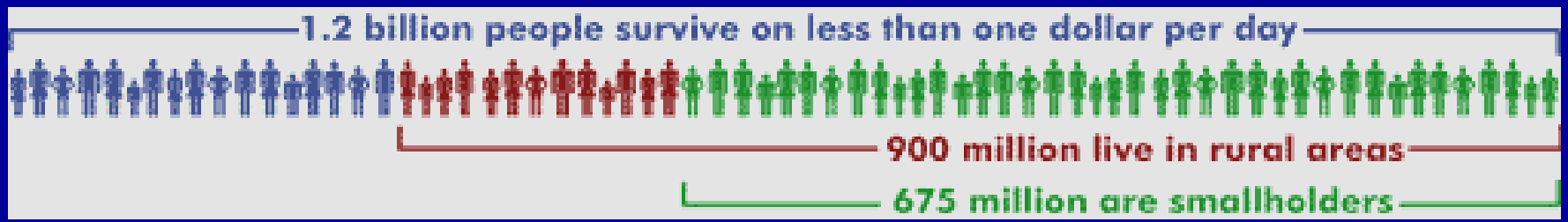
Environment and Public Health Organization (ENPHO) in Kathmandu and Nawalparasi

Rural Water Supply and Sanitation Support Programme (RWSSSP) in Rupandehi and Kapilvastu

International Buddhist Society in Lumbini and surrounding villages

E.F. Schumacher (1973) philosophy: Small is Beautiful

- Simple in design and production
- Low in cost
- Produced from local materials for local use
- With rural focus
- [Does not require electricity]



Schumacher, E. F. Small is Beautiful: A study of economics as if people mattered. Harper and Row, Publishers, New York, 1973.


piyush

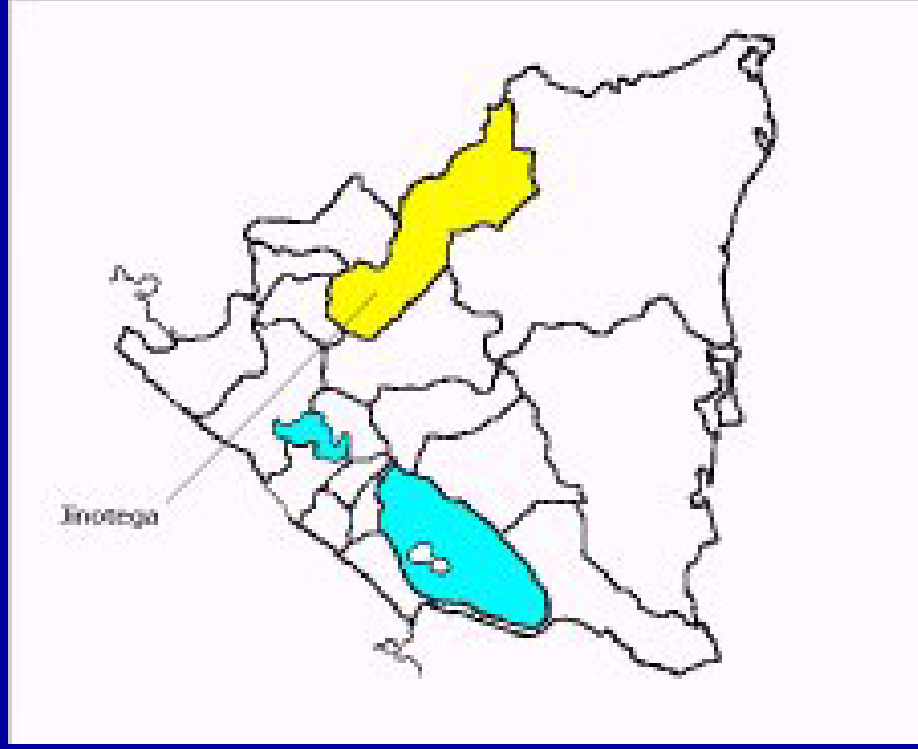
Household water treatment technologies in context

1. Hurricane Mitch relief ‘filter kits’
2. Solar disinfection and its many bottles
3. Social marketing and the safe water system
4. Simple coagulation with complications
5. Ceramic filters bought off the shelf

- What is the role of the developers? Initial and ongoing?
- What is the role of the community? The individual?
- How are the technologies disseminated?
- How sustainable are these projects?
- How could they be made more sustainable?

USAID Hurricane Mitch Filter Project (1998)

- US$560 million damage to W&S infrastructure
- 800,000 people affected
- 30,000 filters distributed



Source of Information:

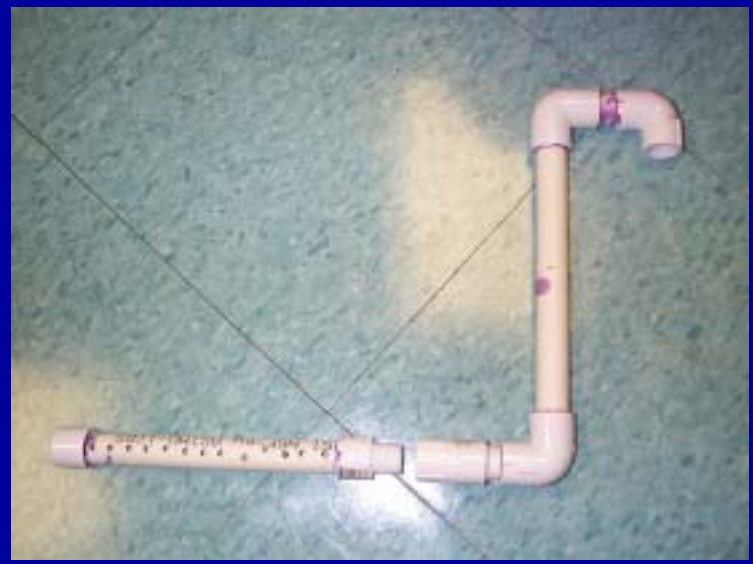
Interviews with personnel at the US AID office in Managua, the capital of Nicaragua, and PROSALUD in the city of Matagalpa

Challenges to those given the task of implementation

- No initial supply of parts!
  - 30,000 filters, many small parts (PVC pipes, elbows, etc) complicates wide distribution of “filter kits”
  - PVC pipes, concrete, etc. are not available in remote villages and must be brought from Managua
- Limited initial education!
  - End users of the project probably did not realize that the filters were not working for reasons easy to fix, e.g. need of cleaning.
- No monitoring!
  - Funds for monitoring the performance of the filters were not assign as part of the project; thus, it is was very difficult for the project managers to assess the effectiveness of the filters and recommend solutions if there were problems.

All hardware requires software

Doña Daysi in her adobe home in the town of Jinotega, proudly displays the filter in her kitchen and remembers how puzzling the whole system seemed from the start. *"At the beginning, we did not know how to use it…After a while, we received some training we were able to copy from each other."*



Issues with “Copy Cats”

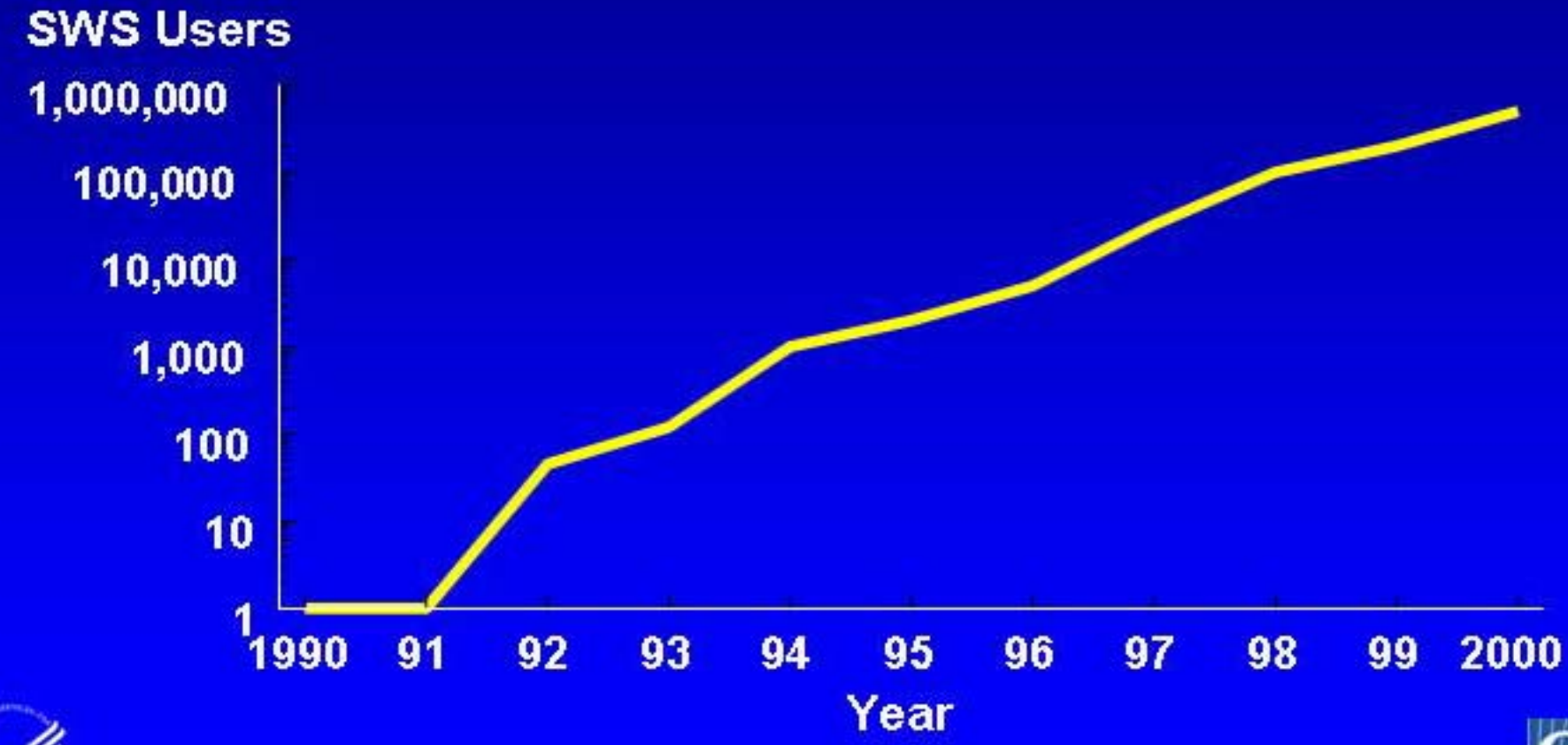
Would you treat your water with solar disinfection (SODIS)?

- Are plastic bottles really everywhere?
- 13 - 54 bottles per day required for an average Nepali family
- Hard to package software (education) with hardware if the hardware is free
- Hot-cold belief system in parts of Latin America, Asia, and Africa?

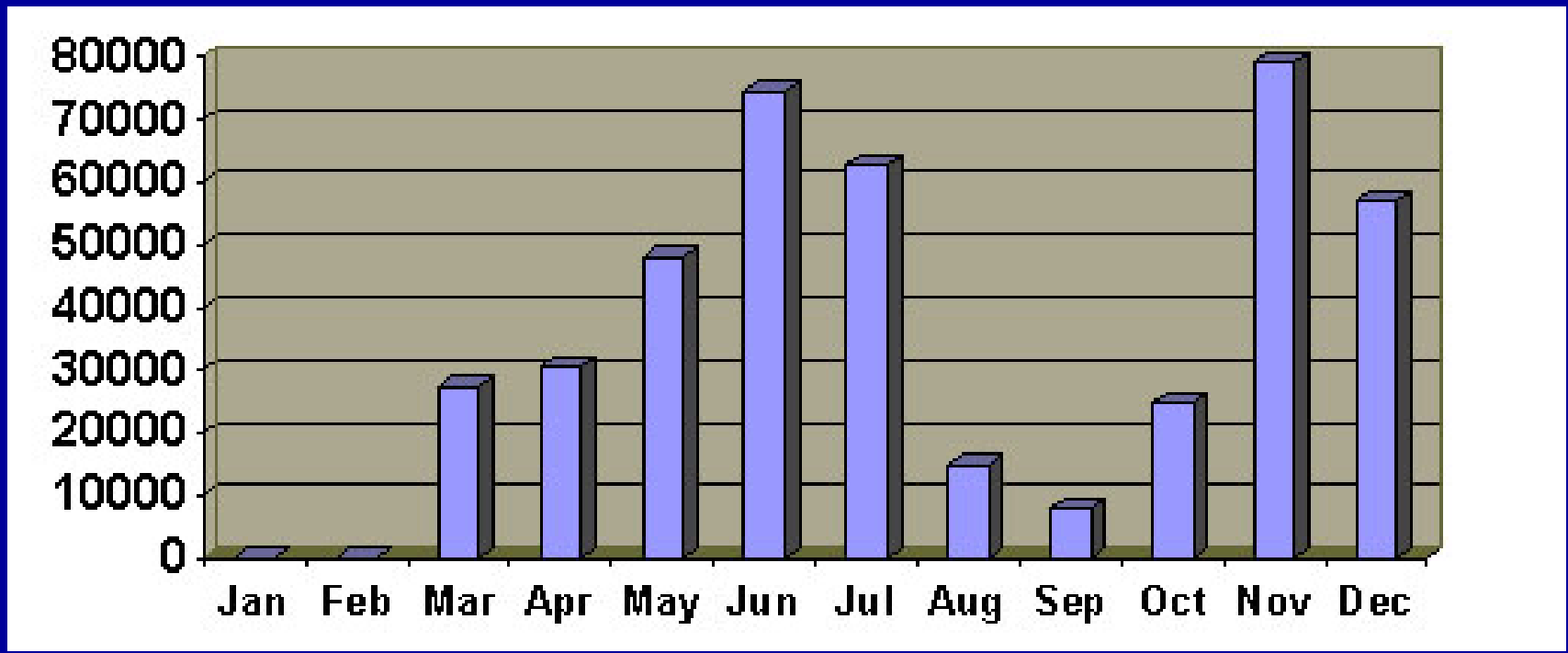
Safe water system takes center stage

- 15 countries on 3 continents
- Consistently reduce episodes of diarrhea in families by approximately 50%
- Cost less than a tenth of a cent per liter of treated water
- Private sector partners ranging from multi-national producers of bleach and plastic vessels, to national wholesalers and retailers, and on down to the level of door-to-door salesman and the owners of small roadside kiosks
- Sales growing daily

Safe Water System Usage, Global Estimates, 1990-2000

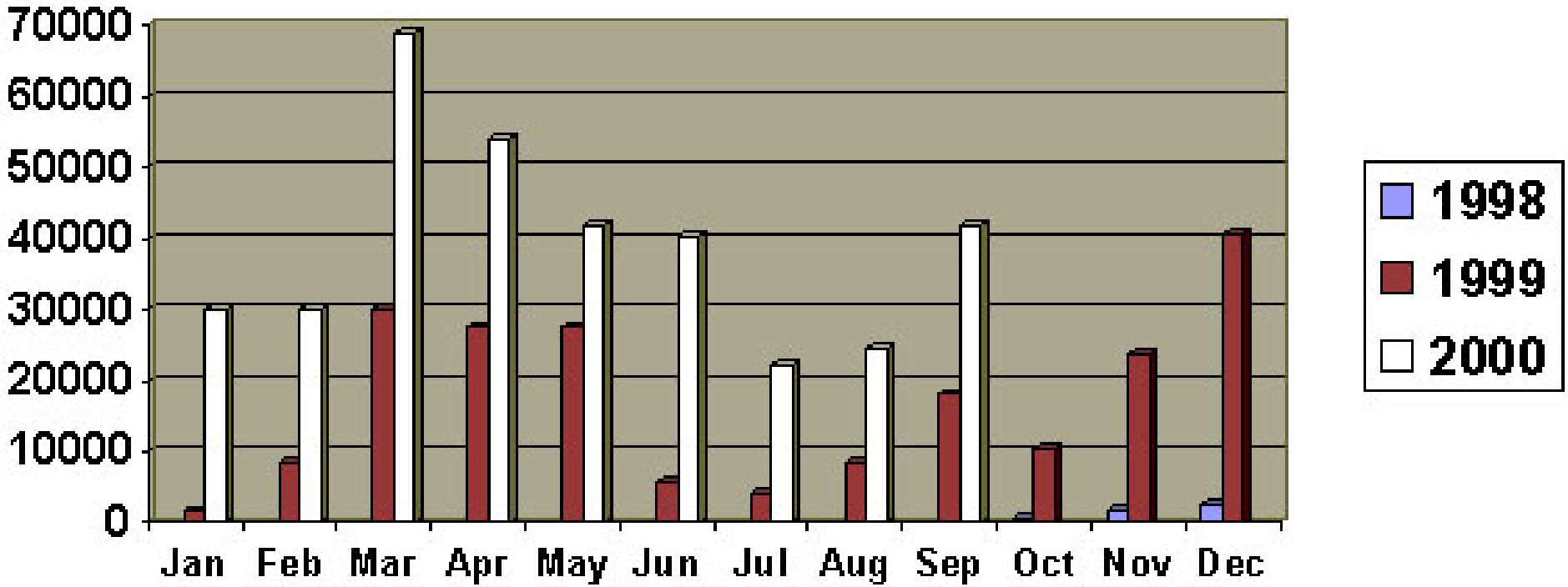


Sales Data from Safe Water System Projects in Madagascar (2000)
Number of Bottles of Sur'Eau Water Treatment Solution sold by PSI



Source: CDC (2003)

Number of Bottles of Clorin Water Treatment Solution Sold by Month by PSI Zambia, 1998, 1999 and 2000



Source: CDC (2003)

Safe Water System Usage, Global Estimates, 2001-2003

- Over 1 million bottles of Clorin sold in Zambia each year in 2001 and 2002
- Over 850,000 bottles of Sur'Eau expected to be sold in Madagascar in 2003
- Through 2002, an estimated 1 million families have been reached with SWS projects

CDC Safe Water System: Beyond what the market will pay?

- Social marketing in Madagascar in April 2000 alone cost almost $200,000 (CDC, 2001)
- Commercial sodium hypochlorite generator can cost between $2000 and $3000 (Van Zyle, 2001)
- Cost of molds to produce a vessel, spigot, and lid are estimated at $100,000
- Molds to make a small bottle of disinfection solution in Bolivia cost $8000 (CDC, 2001)
- The cost to produce the CDC vessels in South Africa is approximately US$2.50. In Zambia, it costs US$5 to purchase and ship one vessel from South Africa
- “Maintaining long-term use of the SWS requires sufficient resources to continue project activities such as social marketing, promotion, and product distribution.” (CDC, 2003)

The many partners of CDC's safe water system

- Funding: USAID, WHO, UNICEF, Rotary International, JICA, Proctor and Gamble Fund
- Production: Local private sector companies
- Implementation: CARE, PSI, other NGOs
- Human Resources: Ministries of Health, NGOs, PSI, private sector (retailers, wholesalers)
- Political support: Ministries of Health, Ministries of Water, municipal governments
- Monitoring and evaluation: CDC, universities

2 Kolshi Arsenic Removal System (EHPHO, Nepal)

Chemicals:

- Ferric Chloride – coagulant
- Hypochlorite – oxidant
- Charcoal – adsorbent

Filter:

- Locally manufactured ceramic
- High porosity

Arsenic Technology Phase I Evaluation Summary

Technology	Technically sound?	Socially acceptable?	Low cost?	Recommend for Phase II?
3-Kolshi	✓	✓	✓	✓
Jerry Can	✗	✗	✓	✗
IOCS	✓	✗	✓	✗
Alumina #1	✓	✗	✗	✗
Alumina #2	✓	✗	✓	✗
2-Kolshi	✓	✓	✓	✓
Treatment Plants	✗	✗	✓	✗
ABF	✓	✓	✓	✓

Source: MIT Dept of Civil and Environmental Engineering and RWSSSP, Nepal (2003)

2-Kolshi system: Seemingly socially acceptable, eh?

- Relatively inexpensive
  - buckets and ceramic filter cost $4.30
  - chemical packets cost $9.7/year (assuming 1 packet per day)
- Adopted from a Bangladesh Design
- Coagulation/coprecipitation used as removal mechanism
- 1,000 filters were distributed to people with immediate needs as a pilot program

❖ Delivery issues (200 families in a village, 1 packet per family per day = 18,000 packets every 3 months)

Ceramic filters

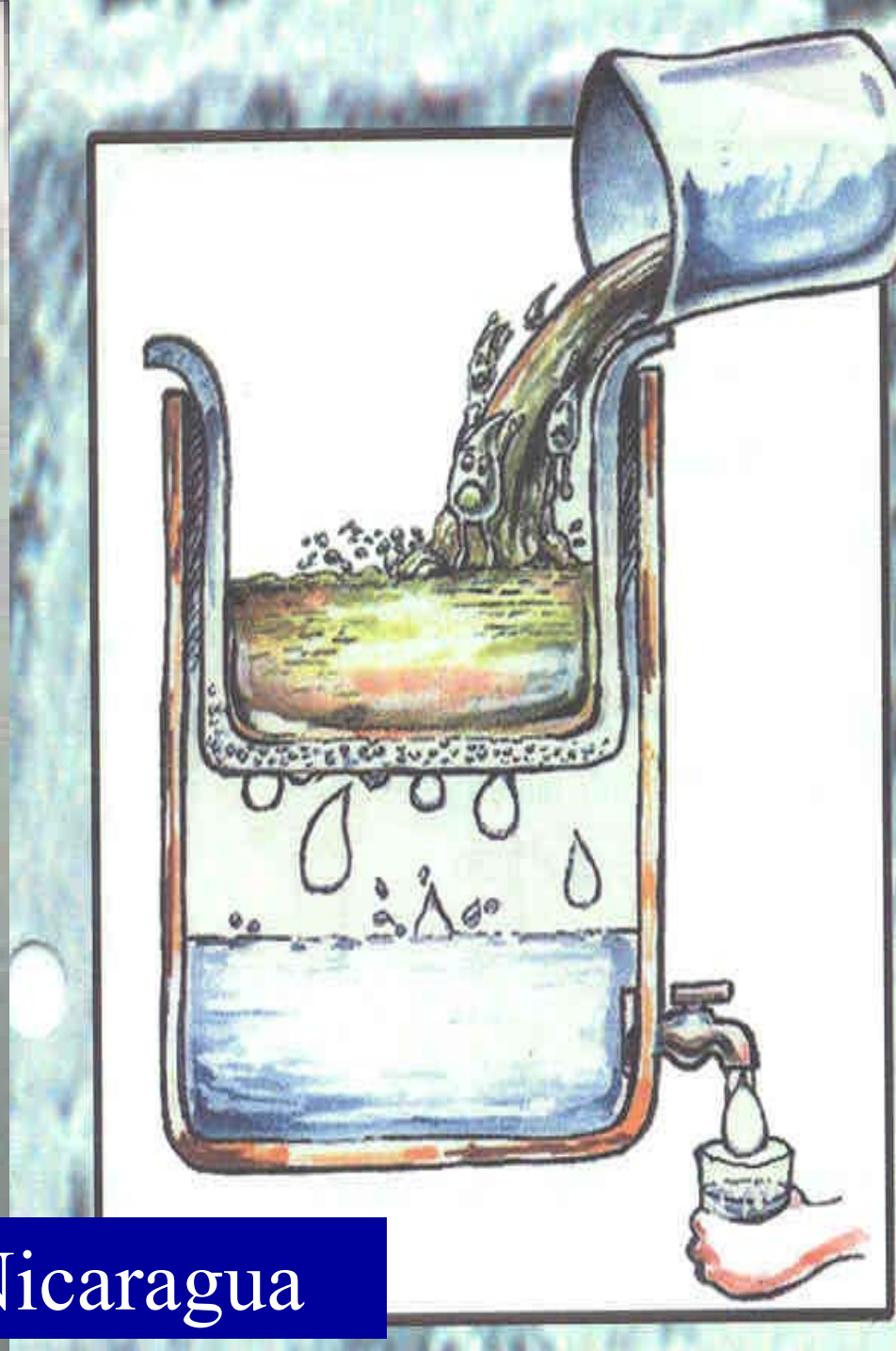
- Widely available
- Inexpensive
- Great variation in quality

Katadyn ("Ceradyn") Ceramic Filter from Switzerland

Hong Phuc Candle Filter – Vietnam

- exterior is an exact imitation of Katadyn
- candles are not of the same high quality.
- only costs $5.00

Terafil Filter, India



Potters for Peace Filter, Nicaragua

Ceramic filters already in market

- How can quality be preserved?
- Imports versus local manufacturing
- Flow rate
- Fragility
- Lifespan (1-5 yrs)
- Knowledge-based technology transfer
- Proprietary concerns

How could we define technical sustainability?

- Sufficient quality and quantity of water
  - Must remove pathogens from enough water for drinking and basic hygienic uses
- How obvious technology failure is to users
- How often maintenance is required
- Robust and durable design
  - How prone the design is to malfunction

❖ The ability for local repair if breakage and/or maintenance is required
  - Must consider parts and/or skills

How do we define social desirability or sustainability?

- All interventions are based upon demand*
  - Importance of ownership as demonstrated by user willingness-to-pay or contribute labor
- *Compatibility* - Consistent with local values and customs
- *Perceived relative advantage* of technology to water providers (primarily women) compared to associated time and economic costs
- *Complexity, Trialability, Observability*
- Given the option, potential users will choose an "appropriate" technology

How could we define financial sustainability?

"Donors increasingly 'demand' financial sustainability, yet continue to fund projects where the prospects of achieving this remain poor."

- Cost recovery
  - Recurrent costs to users (assuming replacement parts or those necessary for repair are locally available)
  - Total initial investment cost
- Successful knowledge-based technology transfer (ie. Parts and knowledge are necessary to be financially sustainable)
- Supply chains intact – parts sourcing through existing commercial infrastructure
- Independence from often undependable outside investors or organizations
- Donors need exit strategy!

What do the illustrations teach us about sustainable project planning?

1. Hurricane Mitch relief 'filter kits'	→	Sustainable project planning
2. Solar disinfection and its many bottles	→	Social: Existing belief system, perceived value, convenience
3. Simple coagulation with complications	→	Institutional: Practicality and backward linkages
4. Social marketing and the safe water system	→	Financial: Role of donors
5. Ceramic filters bought off the shelf	→	Technical: Quality issues with copy cats, technology transfer

Understanding and creating demand

the "complex nature of individuals' perceptions of an innovation"

- Purpose – the product achieves its intended purpose
- Price – the product is available at an acceptable price to the consumer
- Location – the product is available in adequate volumes in the required location
- Quality – the product is of an adequate quality for the consumer
- Consumer knowledge – information about where and how the product can be acquired is available to the consumer

*Technology choice is also crucial to product cost and therefore to consumer demand – the more complex the technology used, the longer the supply chain needed to support it.

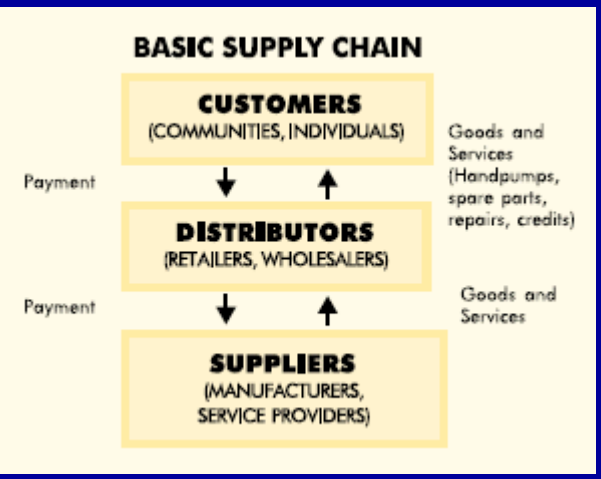
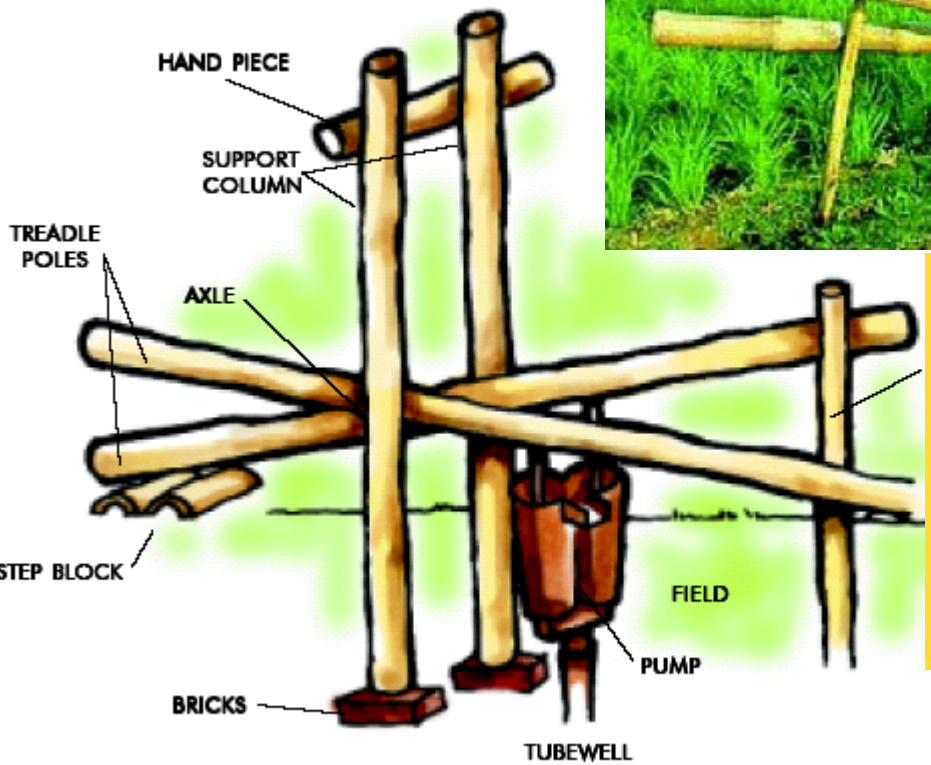


FIGURE 1: A TREADLE PUMP



Developing Private Sector Supply Chains to Deliver Rural Water Technology

The Treadle Pump

An NGO introduces a low-cost irrigation pump to Bangladesh

Source: Water and Sanitation Program (2000)

The treadle pump in Bangladesh

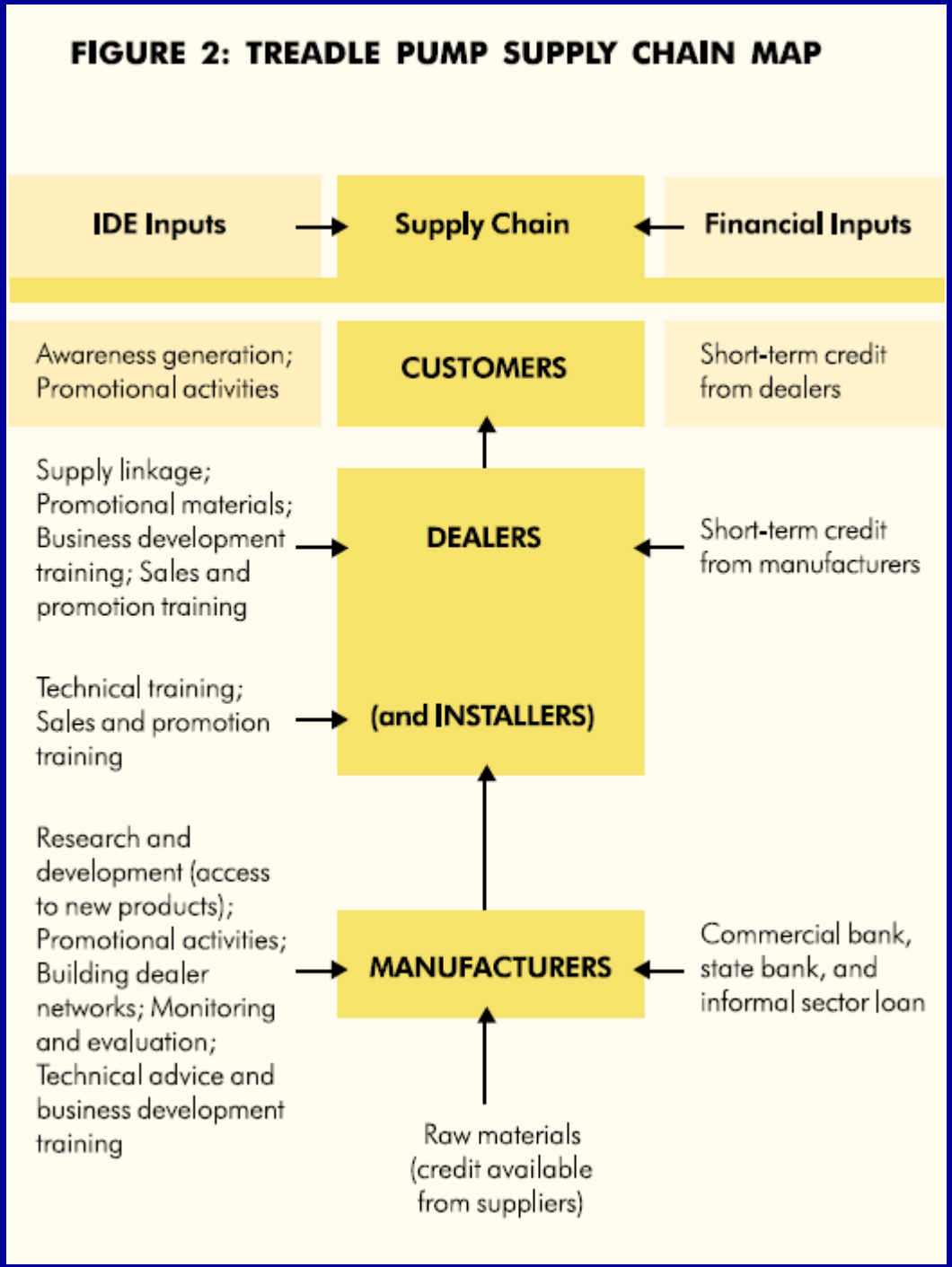

IDE (2003)

- Single farmer can irrigate half an acre in the dry season
- The pump costs $25
- The pump gives farmer on average $100 additional net income per person
- Some farmers make $500-$600 more income per year
- Over 1.3 million treadle pumps have been sold in Bangladesh
- They create an additional income of over 100 million dollars per year
- Many farmers could cross the poverty line and improve their standard of living sustainably
- Many have ‘graduated’ to owners of small diesel pumps

Treadle pumps as micro-enterprises

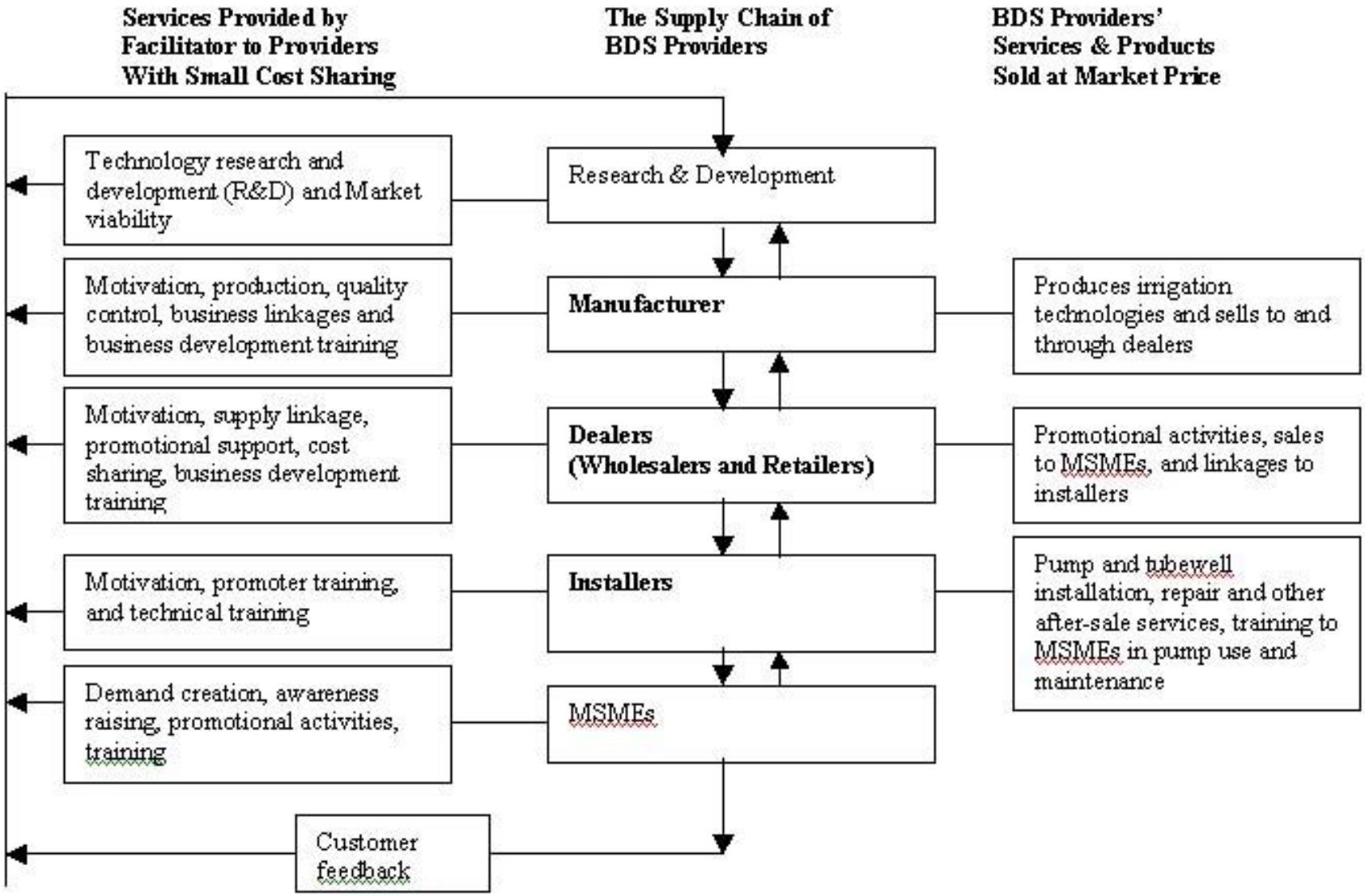
- Small profit margin in manufacturing yet still viable business – profit per pumphead is only 50 cents
- Reasonable profit for 500+ dealers involved in the supply chain ($3 per pump)
- Good business for 10,000 micro-enterprises who supply, sell and/or install the pumps (profit of $2-6 for installing a pump, important sales promoters)
- Again, farmers make an average additional income of 100 $ per year. 20 % of the farmers make 500-600 $ net income per year.

FIGURE 2: TREADLE PUMP SUPPLY CHAIN MAP



Source: Water and Sanitation Program (2000)

Figure 1: BDS Services, Providers and Facilitator



Business Development Services (BDS)
Source: International Development Enterprises (2000)

Conventional Development

Donor → Government or non-government agency → Beneficiary

Market Creation Approach to Development

Donor → Government or non-government agency →

Private Business for delivery (needs profit to be sustainable) → Client (customer demands good product, demand stimulation needed to create new markets)

Source: International Labour Organization (2003)

Performance indicators for projects that are market based show:

- $1 donor investment produces up to $100 benefits
- Requires substantial investments (1-10 million)
- Requires at least 10 years of nurturing (from product development to full market maturity)

Source: International Labour Organization (2003)

Source: International Development Enterprises (2003)

What happens when IDE leaves?

- In 1990, IDE withdrew from districts with high sales
  - "Copy cats" or cheap and lower quality imitations flood the market
  - Reduced customer satisfaction resulted in dropping sales
- IDE responds
  - Set up brand name marketing and sales organization to establish benchmark and to sell treadle pumps through exclusive network
  - Began "generic promotion" of all treadle pumps
  - Quality Partner Catalyst Approach

IDE's lesson's learned

- Quality can be improved by providing business support and incentives to manufacturers
- Large numbers of initial sales alone did not indicate a successfully established product
- Large number of small, independent stakeholders in supply chain desired
- Quality important to ensure sustained demand in higher price range
- Informed customers will sometimes choose lower quality pump with its shorter average lifetime and reduced capital costs

Global projects with improved cook stoves

- About $20 million spent on 137 global programs over 5 year period
- About $9 per stove
- China
  - 140 million stoves installed (1982-1990), 70-80% of total
  - $0.84 government contribution
- India
  - 8 million stoves disseminated
  - $4.30 minimum subsidy
  - Only half stoves in use

REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA

China versus India

- Pilot counties with fuel deficits
- Direct contact between central government and the country = self sustaining rural energy manufacturing and service companies that installed and serviced stoves
- Monitoring by local rural energy offices
- Stoves designed for convenience and attractiveness, not only fuel savings
- Stove users pay full cost of materials and labor
- Government helps through stove construction, training, administration, and promotion support

- Countrywide program
- Bureaucratic administration from center to region to state to district to taluka, other responsibilities
- Local officials too busy for monitoring
- Top-down structure prohibited tailoring of project to local circumstances
- Stove users pay for about half the price, while the government pays the rest. Producer's incentive to construct stoves is, therefore, oriented toward the government.

Source: Smith, Gu, and Qiu (1991)

Nepal cook stove – are they really improved?

- Huge demand for improved cook stoves – women spend 2.5-3.6 hours/day collecting fuel wood
- NGO involvement lacked consistency in approach – 7 NGOs involved over 9 year period working on 18 different projects
- Technology not adapted – Some stoves did not work at high altitudes
- Lack of knowledge-based technology transfer…

Kenya Ceramic Jiko Improved Cook Stove

- Introduced in Kenya in 1982 and mainly targets urban populations who used charcoal
- >700,000 stoves are in use in 1993
- Reported adoption rate of 56% of urban Kenyan households
- Competition between producers reduced the price from as high as US$15.00 to a prices of US$2.50 in 1989

Source: Karekezi, S., 1991: The Development of Stoves and Their Effectiveness. Renewable Energy Technology and Environment, 1, Pergamon Press 46, Oxford, United Kingdom.

Dissemination strategy and success

- Centralized manufacturing of ceramic liners
- Dealers/producers/ installers –
  - 200 artisans and *jua kali* cooperatives build metal shell, buy ceramic liner
  - 13, 600 stoves/month
- Dissemination
  - Pre-existing commercial channels
  - Artesians sell stoves to supermarkets or retailers or direct to the consumers, 90% urban
- External involvement (bilateral, NGO, gov't)
  - provide initial R&D
  - promote and popularize the stove

Secret to success: Adaptive technology?

- "The strength that technology transfer efforts experience when they are designed to support individuals and communities in achieving a diverse set of objectives that are **locally determined**, and not imposed."
- "The most important factor to the successful commercialization of the KCJ is the conscious decision made by the project initiators **not to provide subsidies**."
- "One of the key characteristics of this project was the ability to **utilize existing production and distribution system** for the traditional stove to produce and market the KCJ."
- "Perhaps the most important aspect of the Kenyan cookstove experience is in the **institutional capacity developed** by indigenous organizations such as the Kenya Energy and Environment Organization (KENGO) and the Foundation for Woodstove Dissemination (FWD). They have become sources of regional expertise in many facets of improved cookstove design, dissemination, popularization, and follow-up."

Conclusions?

- Unified vision and goals for development
- Demand must be determined, local conditions valued
  - How? listening, not having preconception of what development means, fund and conduct market assessments
- Invest in adaptive, compatible technology research and development, co-develop the right technology with long term sustainability in mind
  - Community-driven approach, technology centers
- Encourage micro entrepreneur development through incentives – don't give things away, facilitate high quality products
- Planned obsolescence - envision clear exit strategies for external assistance