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Cost Effectivity of High Efficiency Irrigation Systems: Guidelines and Policy Issues for the Forthcoming Projects in Pakistan

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1. Background

The Policy Briefing #13 generated quite a dialogue among the stakeholders and the response received was encouraging on one hand but on the other hand concerns were shown by some of the private sector companies regarding the analysis and information given for costing of the drip irrigation systems.

These companies not only raised the concerns regarding costing of the drip irrigation systems but also provided further data to support a more meaningful analysis. This encouraged the author to collect additional data from the field for further analysis. However, ***the information regarding the performance of recent installations of high efficiency irrigation systems is limited and data regarding impact and life of these systems under local conditions is almost missing. Therefore, readers of this Policy Briefing may keep this limitation in mind while reading this brief. However, future updates would be required to fine tune the guidelines and policy issues.***

Considering the concerns raised by different stakeholders ***a concept of cost-effectivity is developed for making comparison of drip irrigation system materials available in the country***. This concept would provide a comprehensive framework for comparison of materials imported from different countries and produced locally. However, this concept has to be fine tuned with additional field data so that it is acceptable to all the stakeholders.

2. Cost of Drip Irrigation for Fruit Plants

The cost of drip irrigation systems for fruit plants from Zarkasht, Pakistan and Netafim, India is presented based on row to row and plant to plant spacing. The spacing used is for the purpose of costing and can be changed based on the needs of the clients and the concept of drip-scaping provided in the Policy Briefing #12. The variation in the cost provided by the two companies ranges from 59 to 70 %, which is primarily a function of system spacing (**Table 1**).

Table 1. Cost of drip irrigation systems for orchards

Spacing	System Cost (Pak Rs./acre)		Percent
	Zarkasht, Pakistan	Netafim India	
10 X 10	25,539	15006	70
9 X 9	26,778	16043	67
8 X 8	29,521	17873	65
7 X 7	30,747	18483	66
6 X 6	32,746	20130	63
5 X 5	35,600	22448	59
4 X 4	38,870	23729	64
3 X 3	44,800	26962	66

The cost provided by the Netafim, India is for the State Projects. In India, on an average subsidy of 50% is provided by the state, but in reality it varies between various states. The cost provided by Zarkasht, Pakistan represents the cost at which systems are offered to various clients in the private sector. However, the cost of these systems may vary for the public-sector projects and from province to province based on the actual type and design of the system.

The assumptions taken by the two companies while computing the system's cost are illustrated in **Table 2**.

Table 2. Assumptions considered for costing drip irrigation systems

Assumptions	Zarkasht, Pakistan	Netafim India
Pumping System	NO	NO*
Filter for Canal Water	NO	NO
Transportation Cost	NO	NO
Digging Cost	NO	NO
Installation Cost	YES	NO
Installation Tools	NO	NO
Post Installation Service	YES	NO

* NO – not included; ** YES – included

The major variation is that the installation and post-installation services costs are included by the Zarkasht, Pakistan compared to Netafim India. ***Thus, there are variations among the assumptions considered for costing drip irrigation systems by these two companies.***

Important thing to note is that India at least two decades ahead of Pakistan in introducing drip irrigation systems. In addition, India is having at least two major companies producing drip irrigation

materials of international standards – Netafim India and Jain Irrigation Systems Ltd. The country started producing drip irrigation systems since 1985. Therefore, while comparing the cost of Zarkasht Pakistan and Netafim India these aspects be given due consideration. In fact, Pakistan can learn from the Indian experience of last two decades.

The design of drip irrigation systems for matured orchards initially grown under flood conditions is a complex phenomenon, as these plants have established an extensive rooting system. One of the systems tried in Balochistan is the bubbler system having larger discharge, where cost of system is extremely high due to increased size of tubings. Furthermore, the bubbler system can be described as localized flood irrigation. The most cost-effective system for matured orchards would be a hosefed system to irrigate the round basins considering soil-water-plant relationship. The double-lateral drip irrigation system designed and installed by Zarkasht is given in **Figure 1**, which is also a high cost system, but there is a scope for optimizing the system cost considering the multiple diameter lateral pipes and keeping the discharge as optimal as possible.

Figure 1. Double lateral drip irrigation system installed for matured orchards by Zarkasht, Pakistan

3. Cost of Drip Irrigation for Vegetables/Crops

The cost of drip irrigation systems for vegetables and crops is given in **Table 3.** The variation in cost of drip irrigation system for Zarkasht, Pakistan and Netafim, India is between 20-43%, which is primarily a function of system spacing. The variation decreases with the increase in system cost, which is a function of reduced spacing. This variation in cost seems realistic.

Table 3. Cost of drip irrigation systems for vegetables and crops

Spacing	System Cost (Pak Rs./acre)		Percent
	Zarkasht, Pakistan	Netafim India	
4.0	38,541	27023	43
3.0	43,869	31842	38
2.75	46,464	34160	36
2.25	52,150	39711	31
2.0	58,168	44835	30
1.8	62,624	48922	28
1.5	69,304	54778	27
1.2	83,824	68015	23
0.9	104,334	86376	21
0.75	120,032	99918	20

The reasons of increase in cost as stated by Zarkasht, Pakistan are:

- Import cost
- Freight charges
- Warehouse charges
- Financial Costs
- Marketing Costs

These reasons will remain the same for other companies importing materials of multi-national and regional companies from India and China.

The analysis indicated that there are variations in the components of the system cost and the assumptions considered while computing the system cost. This variation made the analysis real difficult, therefore concept of cost effectivity will be more appropriate, while conducting the comparison.

The cost of Chinese systems although given in Policy Briefing #13 but there is additional information available which is summarized as under:

- The drip irrigation system for vegetables and crops is based primarily of extremely thin walled tubings used for sub-mains and driplines, which constitute the major cost of the system.
- Such a system was installed in Hyderabad and was pulled out by the client due to problems associated with the uniformity of water distribution (**Figure 2**). The in-line emission mechanism was not effective and seams of in-line laterals or driplines were leaking, therefore uniformity of distribution is a major question primarily either due to quality

concerns or might be because of pressure variations within the system or exceeding the designed pressure and discharge. Thus, there is a need to have more precise design of such systems.

Figure 2. Thin walled drip irrigation sub-mains and driplines in Hyderabad, Pakistan (imported materials from China).

- For driplines (inline laterals), the most crucial element is filtration and the quality of Chinese and locally produced filters is also a concern. ***The real question is what the local companies are importing from China, as the country is producing whole range of systems having different qualities***. The good example is the import of diesel engine parts from China as most of the local companies are importing low-to-medium quality materials from China for local production of diesel engines. The studies conducted by research institutions indicated that the fuel consumption of energy efficient diesel engines from China is considerably less compared to the locally produced diesel engines of Chinese origin having direct impact on energy use efficiency.
- The life of the thin walled tubings imported from China as indicated by the local company is for two crop seasons (1 year). In China, these tubings are recyclable, therefore there are chances that some of the local companies might import recycle materials.
- The thin walled tubings are being used in countries like USA, China, etc. However, the low level of awareness and current state of mind of Pakistani farmers would require time to get them acquainted with such type of drip irrigation systems. In USA, such systems although of high quality are normally used for one crop season. Therefore, Chinese products can be reasonable for an enlightened farmer who knows the difference in performance and life of a system and who can adjust the system parameters on his own and knows the concept of depreciation versus upfront capital cost. The systems installed at NIAB under controlled conditions performed relatively better as the system was operated by the scientific staff of the institute (**Figure 3**).

Figure 3. Drip irrigation system installed for cotton at NIAB, Faisalabad using materials imported from China.

- The design of drip irrigation systems with thin walled sub-mains and driplines is complex as pressure and discharge variations has to be kept as less as possible because of the quality concerns associated with the in-line emission points. Rise in pressure at any point can affect the uniformity of water distribution.
- The quality also becomes a serious concern in very thin walled tubings because it would take time for farmers to adopt appropriate cultural practices under drip irrigation, otherwise there are chances of puncturing the thin walled tubings by hand tools used for weeding or hoeing. This would require higher maintenance of these tubings under field conditions.
- In China, the local companies are providing facility to the farmers for recycling of thin walled tubings at reduced prices (i.e. at 50% cost). Recycling is a common practice in China. This poses serious concerns for monitoring of the quality of materials imported from China and

other countries. Thus, there is a need to develop state-of-the-art facility for testing of drip irrigation system materials and enforcement of quality standards by the public-sector institutions. The public-sector has to take over the responsibility of regulating the quality of imported and locally produced drip irrigation system materials.

- The response received from the field regarding the quality of thin walled tubing from China is not encouraging. There is a concern about quality and life of these systems. The other problem identified is the low uniformity of distribution of water, which is also a concern, especially if the pressure at any point of the system is higher than the allowable pressure for the thin walled driplines.

4. Framework for Cost-Effectivity of Drip Irrigation Systems

The information provided by different companies and feedback received from various stakeholders provided an opportunity to the author for developing a concept of cost-effectivity because comparison of the cost is difficult as the quality and life of system components vary significantly.

The parameters of quality, life and price can be used to assess the cost-effectivity. ***If the quality of the system is high, price of the system is low and life of the system is long, then the cost-effectivity will be the highest*** as the depreciation will be distributed over a longer period.

The function of cost effectivity is presented as under:

Cost Effectivity = function [Quality, Life, Price]

The concept of cost-effectivity for the three categories of companies either importing or producing drip irrigation systems is presented in **Figure 4**.

The economic optimum is the point where cost-effectivity is optimum - the cost per unit of time is lowest considering the quality of the product. Most of the international companies are providing materials at economic optima considering the concept of cost-effectivity.

If the cost of materials is high per unit of time primarily due to short life of thin walled tubings, the cost effectivity will be low. Such systems are designed for countries where labour cost is high or for countries where farmers are educated but they do not want to invest for longer life systems because these systems interfere with tillage practices at the harvest of the crop, so they pull out the system before the crop harvest.

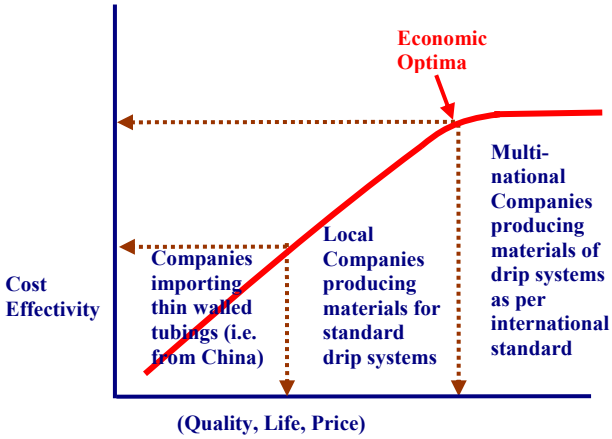

Figure 4. Theoretical framework for cost-effectivity of drip irrigation systems

In Pakistan, majority of people prefer to purchase branded items i.e. the common Pakistanis' still like to buy iron of National Panasonic, radio of Sony, vehicle of Toyota, etc. Therefore, it will be very difficult to introduce short life and low quality materials in Pakistan. But ***any unplanned introduction can lead to system failures and this might affect the Mission of Introducing High Efficiency Irrigation Systems in Pakistan***, because farmers would start blaming the system, even if the problem is with quality of the materials or faulty design or ineffective installation and services.

5. Cost Effectivity of Drip Irrigation Systems for Fruit Plants

For the widely spaced fruit orchards, the standard laterals are used. The life of standard laterals is much higher as the wall thickness is at least 1.2 mm and quality emitters are installed at required spacing, which are normally pressure compensating and provide higher uniformity in distribution of water. Thus, the system life is longer (**Table 4**).

The cost-effectivity of drip irrigation systems for fruit plants is higher for the systems having low annual

capital cost and low annual depreciation cost because of higher quality.

Table 4. Cost-effectivity of drip irrigation systems for orchards

Parameters	Companies Importing Materials from Multi-national Companies (i.e. Zarkasht)	Companies Producing Materials Locally
Quality	High	Medium
Cost	High	Medium
Life	Long	Medium
Cost Effectivity	High	Medium

6. Cost Effectivity of Drip Irrigation Systems for Vegetables and Crops

There are two types of driplines used – the short life for the 1-2 crop seasons and the long life for a period of 10 years.

For example, the in-line laterals (0.9-1.2 mm thick wall) provided by the Zarkasht, Pakistan are of longer life and the company claims life of 10 years (**Table 5**). The thin wall driplines used by the companies importing materials from China can be used for maximum of one year (two crop seasons), if farmers properly role-up the driplines before the harvest of the first crop and maintain it during the first crop season. Puncturing of the thin walled dripline is a serious issue due to ineffective cultural practices. Farmers need to be motivated and trained for new set of cultural practices under these drip irrigation systems. The thirsty rodents also chew the thin walled tubings and there has to be some control for thirsty rodents. Indian experience practiced under the IDE projects is explained in the Policy Briefing #13.

Table 5. Cost-effectivity of drip irrigation systems for vegetables and crops

Parameters	Companies Importing Materials from Multi-national Companies (i.e. Zarkasht)	Companies Importing Material from China
Quality	High	Low to Medium (Recycled and New)
Cost	High	Low
Life	Long	Short (for thin walled tubings)
Cost Effectivity	High	Low
Maintenance Requirement	Low	High

The cost of laterals (short life) on annual basis is more than the thick walled laterals thus the cost-effectivity will be less than the long-life in-line laterals considering both the system cost and higher requirement of maintenance. Maintenance requirement would be higher for systems having short life driplines and sub-mains because these are placed on the surface and subject to vandalism.

The concept of cost-effectivity used is still subjective and will be made more objectives in the follow-up Policy Briefings. But the parameters used for estimating the cost-effectivity would remain the same. In future, the data will be used in quantitative terms and actual values will be assigned for various parameters selected for estimating the cost-effectivity of drip irrigation systems.

7. Regulation and Quality Control

A number of companies are now involved in the import and local production of drip irrigation system materials, which poses some of the serious issues related to regulation and quality control of such materials. These issues include: a) variation in quality and life of drip irrigation materials; b) variations in standards and specification of these materials; c) price of these materials; and d) chances of import of recycled materials especially of thin-walled driplines for vegetables and crops.

The Federal Water Management Cell needs to be restructured and strengthened to assign the new role of regulating the import and local production of drip irrigation system materials through the:

- development of national standards and specifications for the import and local production of drip irrigation materials;
- registration and pre-qualification of companies producing or importing standard materials;
- authorizing permits for the import of drip irrigation materials to the registered companies;
- developing mechanisms and capacity for monitoring of quality control systems for the materials imported or locally produced and installed by various companies under different projects;
- Assist the WRRI-NARC for the establishment of National Laboratory for the Testing of Drip and Sprinkler Irrigation Systems both for quality and efficiency (hydraulic and energy). Quality includes

both for materials (plastic and metal) and for the standards and specifications used for the production of these systems. There is an option to use the existing Plastic Research Institute, Karachi for the testing of plastic materials but for hydraulic and energy testing there is no facility available in the country. Therefore, there is an urgent need to establish a comprehensive facility for the testing of drip and sprinkler irrigation systems covering all aspects of quality, hydraulics and energy; and

- development of feedback system from the clients to monitor and control quality and to regulate the drip irrigation system industry in the country.

8. Guidelines and Policy Issues

The analysis revealed that the policy issues identified in the Policy Briefing #13 would remain the same. ***The real issue is to develop a framework for estimating the cost-effectivity on which experts, private sector companies and the public-sector institutions agree.*** This would require much more data for conducting the analysis. This paper provides an initial framework, which can be fine-tuned in the forthcoming issues of the Policy Briefings. Some of the policy issues related to cost-effectivity are presented as under:

- ***The complexity of drip irrigation system materials and quality concerns demand that the most effective way is to standardize the quality of drip irrigation systems on one hand and on the other hand the public-sector subsidy has to be fixed at around Rs. 25,000 per acre.*** The fixing of the subsidy will resolve number of issues associated with the assessment of the system cost, which varies widely due to the type of crops and the type of systems to be installed. Balance of the system cost would be paid by the farmer.
- ***Initially the drip irrigation systems may be installed for fruit plants and widely spaced creaper-type vegetables and for tubewell commanded areas, where value of water is at premium. In Balochistan, beginning may be made with the diesel-operated tubewells and then extended to the electric-operated tubewells, once the GoB decides about the capping and gradual phasing out of the subsidy for the electric tariff.***
- ***For canal command areas the value of water is low due to extremely low rates of Abiana*** and until the issue of value of water is addressed, farmers would hardly practice any measure related to water conservation. Furthermore, cost of water storage and filtration facility would increase the system cost tremendously. However, ***farmers depending largely on groundwater and growing orchards may be included under specialized ecologies for leachie, citrus, mango and banana. For field crops and fodders, sprinkler systems can be provided instead of drip irrigation systems.***
- ***One of the issues is the low investment capacity of the farmers. Thus, capital cost has to be seen in the context of investment capacity of the farmer. The low-cost driplines with short-life might be attractive to those farmers who are not in a position to invest higher amounts to install systems having higher quality.*** However, the maintenance requirements would be higher for the short-life dripline systems – the low-cost systems. ***But in reality, the cost-effectivity will be low compared to standard in-line laterals of 0.9-1.2 mm of wall thickness.***
- Initially, most of the companies would be involved in the import of materials from different sources (multi-national, Indian and Chinese Companies). Most of these materials are manufactured using different standards, quality and life. Therefore, ***there is an urgent need to establish a state-of-the-art National Testing Laboratory for the testing of drip irrigation materials. Such a facility may be established at WRRI-NARC of Pakistan Agricultural Research Council, Islamabad, as this institute was the pioneer in initiating research and development of sprinkler and drip irrigation systems in Pakistan.*** They have also developed capacity and field facility for testing of these products. Laboratory support would be required for testing of plastic materials and hydraulics of the tubings, emission points and sprinklers.
- ***The Federal Water Management Cell, Ministry of Food, Agriculture and Livestock may be restructured and strengthened to develop mechanisms for regulating the quality of imported materials of drip and sprinkler irrigation systems to meet the international standards.***
- The Federal Water Management Cell of the Ministry of Food, Agriculture and Livestock may initiate the bilateral arrangements with the Chinese Government to identify companies producing quality materials of drip irrigation systems and facilitate the local plastic industry to enter into joint ventures for producing quality materials in Pakistan. Similar, arrangements may be made with other multi-national companies to support local production of drip irrigation systems in Pakistan in

a partnership with the local companies like Dadex Eternit, etc.

- The two specialized trainings designed under the ADB TA Grant Project [TA-4560 (PAK)] includes: a) Optimization of the Design of High Efficiency Irrigation Systems; b) Maintenance and Operation of High Efficiency Irrigation Systems. The concept of cost-effectivity will be used in these trainings for optimizing the design and operation of these systems. The private sector companies and the public-sector institutions will be consulted to join hands to have this course a real on-job training to develop innovative and cost-effective approaches for the design and operation of micro-irrigation systems, which suit local conditions and address farmers' investment capacity.

Acknowledgement: *The author would like to thank the private sector companies for sharing the data for the preparation of the Policy Briefings #13 and #15.The process will be continued as new actors will join and due to rapid developments in this area future Policy Briefings will address some of the new and emerging issues.*

The Policy Briefings is a Series of Issues, which will be prepared and circulated to the policy and decision makers in the province of Balochistan and in other provinces of the Country with an objective to synthesize and disseminate the studies outputs under the TA-4560 (PAK).

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The Policy Briefings are also based on the research work done by other national and international institutions with an objective to get benefit of the work done elsewhere.

The comments and suggestions can be sent at the following address:

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The topic to be addressed in the next Issue of Policy Briefings is: "Restructuring National Agricultural Research System (NARS) – the NARS Balochistan". The topics include: a) State of Agricultural Research and Extension; b) National Agricultural Research System; c)Re-organizing NARS; d) Re-organizing NARS-B; e)Researchable Issues; f) Research Thrust Areas; and g)Coordination of NARS-B and Linkages.