

Chapter 3 – Outcome of network projects

The activities of CSIR during the Tenth Five Year Plan provided for target oriented network R&D. As per para 2.1.1 of the Guidelines, the project proposals should detail out the deliverables/outcome over a five year period in terms of financial, economical, technological, societal benefits, etc. Audit evaluated the outcome of research from network projects on the following parameters:

- number of technologies developed;
- intellectual property in terms of number of patents;
- publishing of research papers in scientific journals;
- generation of external cash flows¹⁶;
- extent of inter laboratory cooperation¹⁷; and
- development of human resources.

Based on these parameters, the outcome of 27 selected projects is discussed in the succeeding paragraphs.

3.1 Development and commercialisation of technology

As stated earlier in para 2.4 of this report, network projects of CSIR aimed at generation of knowledge, usable knowledge and useful knowledge as products. Therefore, those projects that targeted usable knowledge and useful knowledge as products were to be expected to afford commercialisable results.

A total of 399 technologies were developed from 27 network projects examined in audit, of which 51 technologies were transferred to end users and 38 technologies were commercialised and revenue of ₹3.83 crore was realised as of July 2012. The detailed position of project wise development and commercialisation of technologies is given in **Appendix VIII**. The summarised position is given in Table 5:

¹⁶ External cash flow is the total amount from various external sources like royalties, licensing, awards, contract R&D, consultancies, etc.

¹⁷ During Entry Conference (November 2011), CSIR suggested that Audit should evaluate the outcome of the networked R&D efforts of CSIR Laboratories by covering both tangible and intangible benefits. The suggestion was agreed to and CSIR was requested to provide adequate inputs for evaluation of intangible benefits. However, no such input was received from CSIR.

Table 5: Summarised position of total number of technologies developed and transferred from 27 selected network projects

Range of technologies developed through a single project	Number of projects in which range of technologies in col. 1 were developed	Total number of technologies			Expenditure incurred on the projects (₹ in crore)	Revenue generated on transfer/ commercialisation of technologies (₹ in crore)	Number of technologies commercialised as percentage of number of technologies developed	Revenue generated from sale of technologies as a percentage of expenditure incurred on the project
		Developed	Transferred	Commercialised				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	3	Nil	Nil	Nil	41.84	Nil	Nil	Nil
1-10	12	67	21	9	280.45	0.90	13	0.32
11-20	3	40	5	4	68.20	2.28	10	3.34
21-30	5	115	3	3	118.86	0.13	3	0.10
31-40	1	33	19	19	19.34	0.01	58	0.05
41-50	2	82	3	3	44.49	0.51	4	1.15
51 and above	1	62	0	0	48.62	0	0	0
Total	27	399	51	38	621.80	3.83	10	0.62

Audit observed that:

- The research carried out with a total expenditure of ₹621.80 crore through the 27 projects resulted in commercialisation of only 10 *per cent* of the technologies developed and revenue generation of ₹3.83 crore (till July 2012) which was less than one *per cent* of the total expenditure on network projects.
- Of ₹3.83 crore revenue generated from 27 projects, only two¹⁸ projects contributed ₹2.28 crore and ₹51 lakh respectively.
- There was 'nil' technology development in case of three projects costing ₹41.84 crore.
- Three projects developed 144 technologies, but were able to commercialise only three technologies which generated revenue of ₹51 lakh.
- In the case of two projects, although more than 20 technologies were developed from each project, none of them were transferred or commercialised.

¹⁸ (i) Environment friendly leather processing technology and (ii) Industrial waste minimisation and clean up

The above statistics indicate that although CSIR was able to increase the stock of knowledge, it failed to transfer the same for larger benefits to society.

As already mentioned in Chapter 2 of this report, the nodal laboratories were required to detail out the measurable deliverables/outcome of their projects over a five year period in terms of financial, economical, technological, societal benefits, etc. in the project proposals of the network projects. Audit, however, observed that out of 27 projects, targets for generation of technologies were defined in seven projects only. The status is as under:

Table 6: Targets and achievements of projects in which measurable deliverables in terms of generation of technologies were defined.

Name of Project	Nodal laboratory	Number of technologies targeted	Number of technologies developed	Shortfall (-)/ Excess(+)	Percentage of shortfall (-)/ Excess(+)
Industrial waste minimisation and clean up	NEERI	10	41	(+)31	(+)310
Developing new building construction materials	CBRI	10	33	(+)23	(+)230
Developing cells and tissue engineering	CCMB	3	2	(-)1	(-)33
Medicinal plant chemotypes for enhanced marker and value added compounds	CIMAP	20	7	(-)13	(-)65
Electronics for societal purposes	CSIO	30	11	(-)19	(-)63
New and improved road technologies	CRRRI	36	21	(-)15	(-)42
Drug target development using in-silico biology	IGIB	250	62	(-)188	(-)75
Total		359	177	(-)182	(-)51

Thus, target of development of technologies was exceeded in the case of two projects and shortfall in five projects ranged from 33 *per cent* to 75 *per cent*. No targets were set in remaining 20 projects.

Further, target for revenue realisation from sale of technologies was set in only one project¹⁹. Against target of revenue realisation of ₹10 crore from the project, achievement was 'nil'.

¹⁹ Drug target development using in-silico biology- nodal laboratory: IGIB

CSIR stated (July 2012) that direct economic impact of any project would need post project surveillance and assessment of the returns after a period of ten years of implementation of the project. CSIR added that its recent economic analysis of several past projects had shown that total direct benefit to CSIR plus licensee plus user beneficiary was on an average over thousand times higher than the revenue received/granted by CSIR over a 10 year period.

The reply of CSIR is not acceptable as (a) in many projects, targets were not defined; (b) targets were to be achieved over a five year period and (c) revenue realisation was less than one *per cent* of expenditure as of July 2012. Further no document to justify revenue realisation over thousand times over investment was on record.

3.2 Generation of intellectual property

Major achievements of scientific research are primarily reflected in intellectual property rights (patents) and research publications. The Guidelines also encouraged culture of multi-lab and multi-author patents/papers under the network projects (para 3.9 (iv)). This was reiterated by CSIR in the entry conference (November 2011) wherein it was stated that involvement of scientists of more than one laboratory in filing patents together was very important.

CSIR's achievement as of July 2012 in generation of intellectual property in terms of filing and grant of patents from 27 projects is given below (patents filed both in India and abroad):

Table 7: Patents filed and granted from 27 selected network projects

Range of patents filed under a single network project	Number of network projects in which patents in col. 1 were filed	Total number of patents		Number of joint patents		Number of patents filed from earlier R&D projects but marked under network projects	Net patents filed from network projects (Col. 3-Col.7)	Patent granted to patent filed in percentage
		Filed	Granted	Filed	Granted			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	3	0	0	0	0	0	0	0
1-10	15	73	31	2	0	6	67	46
11-20	5	78	13	20	2	12	66	20
21-30	3	75	50	13	6	0	75	67
31-40	1	38	9	6	0	0	38	24
TOTAL	27	264	103	41	8	18	246	42

It can be seen from the above table that:

- In all 264 patents were filed out of which 103 patents were granted.
- Out of 264 patents, only 41 patents constituting 16 *per cent* were filed jointly in networked mode.
- Of 41 patents filed jointly only eight patents (20 *per cent*) were granted.
- Three projects implemented at a cost of ₹61 crore did not generate any patent.

Audit further observed that out of 264 patents stated to have been filed, 18 patents were actually generated from earlier R&D projects but were exhibited under network projects.

Further, out of 27 network projects selected, only 13 project proposals contained measurable deliverables for generation of intellectual property in terms of number of patents. The achievement of these 13 projects is given in Table 8:

Table 8: Achievements in terms of generation of patents for projects in which targets were set

Name of Project	Nodal laboratory	Number of patents targeted to be obtained	Actual number of patents filed	Shortfall	Percentage of shortfall
Developing new building construction materials	CBRI	20	19	1	5
Developing capabilities & facilities for Micro-electromechanical systems (MEMS) and sensors	CEERI	50	16	34	68
Positioning Indian nutraceuticals and nutrigenomics in a global platform	CFTRI	60	7	53	88
Medicinal plant chemotypes for enhanced marker and value added compounds	CIMAP	25	10	15	60
Capacity building for coastal placer mineral mining	CIMFR	20	2	18	90
Developing capabilities in advanced manufacturing technology	CMERI	12	2	10	83
Development and commercialisation of new bioactives and traditional preparation	CSIR Hq.	50	29	21	42
New and improved road technologies	CRRI	7	1	6	86
Drug target development using in-silico biology	IGIB	50	18	32	64
Newer scientific herbal preparations for global positioning	IIIM	7	5	2	29

Name of Project	Nodal laboratory	Number of patents targeted to be obtained	Actual number of patents filed	Shortfall	Percentage of shortfall
Exploration and exploitation of microbial wealth of India for novel compounds and biotransformation process	IMTECH	20	14	6	30
Industrial waste minimisation and clean up	NEERI	111	24	87	78
Design analysis and health assessment of Special structures including bridges	SERC	5	2	3	60
Total		437	149	288	66

Thus, it is seen from the table that none of the 13 projects in which targets for generation of patents were set, achieved the same. The shortfall ranged from five to 90 *per cent*.

CSIR did not offer any comment on above issue (November 2013).

3.3 Publishing of research papers

As mentioned in para 3.3 above, major achievements of a scientific research organisation are reflected in its research publications. Besides, para 3.9 (iv) of the Guidelines provided for promoting the culture of multi-lab and multi-author papers. The Guidelines further stipulated that acknowledgement in publications to the specific network program should be included as means of relating outputs of the project (para 2.5.3.3).

A total of 2008 research papers were published from 27 network projects selected for audit. The details are given in Table 9:

Table 9: Number of publications from 27 network projects

Number of publications from a single network project	Number of network projects from which the publications in col.1 were made	Total number of papers published	Number of papers published jointly	Names of the nodal laboratories that undertook the network projects
(1)	(2)	(3)	(4)	(5)
1-30	5	94	6	CIMFR, CFTRI, CSIO, IIIM and IIP
31-60	10	403	31	CCMB, CGCRI, CIMAP, CIMFR, CMERI, CSIR (HQ), CRRRI, IICB, IMMT and NIO
61-90	4	288	7	CEERI, CLRI, IMTECH and NPL
91 and above	8	1,223	60	CBRI, CDRI, IGIB, NAL, NCL, NEERI, NML and SERC
TOTAL	27	2,008	104	

From the table it can be seen that although CSIR had achieved a noteworthy average of 74 publications per network project, only 104 publications constituting five *per cent* of the total were brought out jointly by participating laboratories. Audit further observed that

- There were no joint publications in 17 out of 27 network projects.
- Although 2008 papers were stated to be published from the 27 projects, there was no record to show acknowledgment in publications to the specific network project, as required under the Guidelines.

An indication of quality of a publication is impact factor²⁰ of the journal in which the paper is published. Impact factor indicates standing of the journal in the world and is used to evaluate research output of scientists. The value of impact factor generally lies between 0 and 50 but varies from subject to subject.

The journal impact factors of research publications from 27 network projects was as shown in Table 10:

Table 10: Impact factor of publications

Range of Impact Factor	Number of Publications
0	677
0 to 1	324
1 to 2	297
2 to 5	604
5 to 10	76
10 to 20	7
20 to 30	0
Above 30	1
Not available	22
Total	2,008

It can be seen from the table that

- 677 papers (34 *per cent*) out of 2,008 had a journal impact factor of zero and therefore were not quoted anywhere.

²⁰ Impact factor is defined as the ratio of the number of citations received by a research paper in a particular year to the number of research papers published over a fixed period of time (usually two years), in a particular periodic publication, i.e journal.

- Of 2,008 research papers published, 1,298 papers (65 *per cent*) had journal impact factor below 2 and 1,902 (95 *per cent*) papers had journal impact factor below 5.
- Only 84 papers (4.18 *per cent*) had journal impact factor above 5.

Thus, although network projects resulted into a large number of published research papers, a significant number of these (95 *per cent*) had impact factor of less than 2.

Audit also observed that targets for publications were set in only nine projects and no targets were fixed for joint publications. The achievements under these nine projects are given in Table 11:

Table 11: Achievements in terms of research papers published in nine projects where targets were set

Name of Project	Nodal laboratory	Number of papers proposed to be published	Actual number of papers published	Shortfall (-)/ Excess (+)	Percentage of shortfall (-)/ excess (+)
Medicinal plant chemotypes for enhanced marker and value added compounds	CIMAP	25	35	(+)10	(+)40
Capacity building for coastal placer mineral mining	CIMFR	40	47	(+)7	(+)18
Developing capabilities in advanced manufacturing technology	CMERI	25	44	(+)19	(+)76
Drug target development using in-silico biology	IGIB	100	129	(+)29	(+)29
Exploration and exploitation of microbial wealth of India for novel compounds and biotransformation process	IMTECH	12	69	(+)57	(+)475
Design analysis and health assessment of Special structures including bridges	SERC	50	357	(+)307	(+)614
Industrial waste minimisation and clean up	NEERI	295	115	(-)180	(-)61
Developing new building construction materials	CBRI	150	134	(-)16	(-)11
Positioning Indian nutraceuticals and neutrigenomics in a global platform	CFTRI	35	28	(-)7	(-)20
Total		732	958	(+)226	(+)31

It can be seen that targets for publishing of research papers were exceeded in six projects and there was shortfall in remaining three projects.

Thus, the overall achievement of CSIR in terms of number of research papers published was noteworthy, however, the efficacy of networking through involvement of more than one laboratory in writing scientific papers was insignificant.

CSIR did not offer comments on the issue (November 2013).

3.4 Generation of External Cash Flow

One of the performance indicators prescribed in the Guidelines was extent of external cash flow (ECF) realised through projects. The status of ECF from 27 selected projects as of July 2012 is given in Table 12:

Table 12: Status of External Cash Flow from 27 selected projects

ECF generated from a single network project	Number of projects from which ECF in Col.1 generated	Total ECF generated (₹ in crore)	Names of the nodal laboratories
(1)	(2)	(3)	(4)
No ECF	9	0	CCMB, CDRI, CFTRI, CSIO, CSIR Hq, IICB, IIIM, IMTECH and NIO
Upto ₹1 crore	4	0.52	CIMAP, IIP, NCL and SERC
₹1-2 crore	4	6.93	CGCRI, CIMFR, IMMT and NEERI
₹2-3 crore	1	2.27	CLRI
₹3-4 crore	Nil	Nil	-
₹4-5 crore	1	4.01	CMERI
₹5 -10 crore	5	38.75	CBRI, CIMFR, CRRRI, IGIB and NML
More than ₹10 crore	3	142.26	CEERI, NAL and NPL
Total	27	194.74	

It can be seen from the above table that there was no ECF from nine network projects. Total expenditure incurred on these projects was ₹199.16 crore.

Audit further observed that out of ₹194.74 crore stated to have been generated by 18 projects, amount of ₹115 crore was not generated from network projects, but from sponsored and grant-in-aid projects. Thus, actual ECF from network projects was only ₹79.74 crore.

Further, it was seen that targets for generation of ECF were given in only nine projects. The achievement of these nine projects is given in Table 13:

Table 13: Achievements in terms of generation of ECF from nine projects where targets were set

(Amount in ₹ crore)

Name of Project	Nodal laboratory	Amount of ECF proposed to be generated	Amount of ECF generated	Shortfall	Percentage of shortfall
Developing new building construction materials	CBRI	9.5	9.5	0	0
Developing capabilities & facilities for Micro-electromechanical systems (MEMS) and sensors	CEERI	15	10.5	4.5	30
Positioning Indian nutraceuticals and nutrigenomics in a global platform	CFTRI	2	0	2	100
Medicinal plant chemotypes for enhanced marker and value added compounds	CIMAP	2.5	0.21	2.29	92
Environment friendly leather processing technology	CLRI	40	2.275	37.725	94
Developing capabilities in advanced manufacturing technology	CMERI	16	4	12	75
New and improved road technologies	CRRRI	9	8.1	0.9	10
Exploration and exploitation of microbial wealth of India for novel compounds and biotransformation process	IMTECH	2.5	0	2.5	100
Physico-mechanical, electrical and electronic standards	NPL	20.8	16.76	4.04	19
TOTAL		117.30	51.35	65.95	56

Thus ECF target was achieved in only one project. The shortfall in the remaining eight projects was between 10 to 100 per cent.

CSIR did not offer comments on the observation (November 2013).

Recommendation 7:

CSIR may ensure that targets are set in a judicious manner after assessing the available resources and associated risks of research, so as to present a realistic picture.

3.5 Other outcomes

3.5.1 Development of human resources

According to Para 4.2 of the Guidelines, Task Force was required to submit quarterly performance report of network projects to CSIR. One of the parameters for reporting significant scientific and technical achievements was human resource development. Although no targets were set for development of human resources, the position in terms of number of Ph.Ds awarded and number of Project Assistants trained from 27 selected network projects was as below:

Table 14: Number of Ph.Ds awarded from network projects

Number of Ph.Ds awarded from a single network project	No. of Projects from which Ph.Ds in Col.1 awarded	Total number of Ph.Ds.	Nodal laboratories
(1)	(2)	(3)	(4)
0	5	0	CCMB, CIMFR, CSIO, CRRRI, NPL
1-20	20	135	CFTRI, IIIM, IIP, CGCRI, CIMAP, CIMFR, CMERI, CSIR (HQ), IICB, IMMT, NIO, CEERI, CLRI, IMTECH CBRI, NAL, NCL, NEERI, NML and SERC
21-40	1	30	CDRI
41-60	0	0	-
61 and above	1	66	IGIB
Total	27	231	

Table 15: Number of Project Assistants trained from network projects

Number of Project Assistants trained from a single network project	No. of Projects in which Project Assistants in Col.1 trained	Total number of Project Assistants	Nodal laboratories
(1)	(2)	(3)	(4)
0	5	0	CDRI, CFTRI, NAL, NCL and NPL
1-30	13	219	CCMB, IIIM, CGCRI, CIMAP, CIMFR, CMERI, CSIO, IMMT, NIO, CEERI, CLRI and NML
31-60	4	178	CRRI, IIP, IMTECH and SERC
61-90	1	81	CSIR (HQ)
91 and above	4	580	CBRI, IGIB, NEERI and IICB
Total	27	1058	

It would be seen from the above data that:

- A total of 231 Ph.Ds were awarded and 1058 Project Assistants trained through network projects.
- No Ph.D was awarded in five projects.
- No trained Project Assistant developed in five projects.

Audit further observed that of 231 Ph.Ds stated to have been produced, in six cases the thesis of Ph.D had already been accepted prior to commencement of the projects.

CSIR did not offer any comment on the issue (November 2013).