Economic and Technology Management Review. Vol. 1 No. 1 (June) 2006: 29–36

Public sector agricultural R&D and technology management: An assessment on mechanism and structures

(P&P pertanian dan pengurusan teknologi di sektor awam: Satu penilaian mekanisma dan struktur)

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Key words: public sector, agricultural R&D, technology, assessment, mechanism, structures

Abstract

A study on researchers in public Research and Development (R&D) agencies and institutions was conducted in 2004 with the objectives of describing, characterizing and evaluating the existing mechanisms and structures of the public sector R&D within the agricultural sector. A total of 337 researchers from R&D agricultural agencies and institutions were selected by stratified sampling. Primary data were collected by field surveys using structured questionnaires via both personal interviews and postal surveys. Findings showed that in the year 2000, about 33.50% (1,276 persons) were involved in agricultural research. The preferred R&D activities undertaken were applied research, basic and fundamental research, socio-economic and marketing research and others. The substantial increase in R&D expenditures by the public sector in the year 2000 reflected a stronger emphasis and commitment in the development of agricultural technology, in line with the National Agricultural Policy 1998–2010. Funding for R&D in order of importance were from IRPA, development and operating budget and external funding such as from the Japanese Government, ACIAR, European Union and others. The establishment of technology transfer units to facilitate technology transfer was emphasized over patenting technology (74.70% versus 38.62%). The study showed that possible areas of support urgently needed by the public sector R&D were funding, training, ability to use private laboratories facilities, marketing information and dedicated researchers. The percentage breakdown of R&D output transferred directly to the clients was 50.15%, followed by extension agents (41.25%), direct application by the institute(35.6%), yet to be applied and commercialised (35.01%) and no takers (9.50%). The R&D activities of the private sector were highly applicable and problem solving than the public sector. It was also found that the majority of research undertaken did not include potential clients from the early stage of R&D, and thus affected the adoption or commercialisation of R&D outputs. To strengthen the national R&D capability, the government policy should ensure that the public sector R&D complement and support the private sector R&D.

Introduction

The importance of research and development (R&D) in the development of a country is well recognized. Many countries have embarked on developing indigenous scientific and technology capabilities, focusing on the development of R&D skills. Most of the agriculture technology development outputs

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in Malaysia were from the various government R&D institutions, agencies and universities. Presently, there are about 20 R&D institutions involved in agricultural R&D.

Generally, technologies generated by the various R&D institutions were the primary source of agricultural productivity in Malaysia (Anon. 1991). Empirical studies indicated that high economic returns came from the public sector investments in agricultural research (Pray 2002), and that the R&D expenditure of the agricultural sector is very unlikely to increase from the overall R&D budgets. In Malaysia, the public agricultural sector R&D allocation declined from 49% in the sixth Malaysia Plan (6MP) to 38% in the first half of the 7MP (Anon. 1996). Recent developments indicated an increase share of responsibility in R&D being undertaken by the private sector. R&D spending by the private sector has increased three-fold since the end of 5MP, with a total expenditure of RM246 million during 6MP (Anon. 1999). This figure showed the total R&D expenditure enjoyed by all sectors, including agriculture. Hence, the need for a greater accountability and value-for-money R&D activities with high potential for commercialisation in the public sector is becoming more critical. This then calls for a more prudent and efficient R&D management in the public sector.

Objective

The overall objective is to describe, characterise and assess the mechanism and structures of public sector R&D and the subsequent technology transfer for generating and promoting technologies which are applicable to the agricultural sector. Specifically, the objectives are:

- To identify pertinent planning and implementation mechanism characteristics of private sector R&D
- To assess financial allocation and manpower utilisation trends in public sector R&D investment
- To identify public sector link between research output and technology transfer and marketing
- To analyse the development and up scaling of knowledge and technology in the process of commercialisation and application of R&D outputs
- To document the differences and similarities of technology generation and transfer between private and public sector R&D
- To identify possible problems and constraints that could hinder further expansion in public sector R&D
- To provide suggestions and some policy options for supporting and strengthening public sector R&D in the national technology policy

Methodology

This study involved the collection of primary and secondary data. Primary data were collected by field surveys using structured questionnaires via both personal interviews and postal surveys. A total of 337 respondents (research officers) were collected by stratified sampling. They represented government agencies and research institutes involved in agricultural R&D, such as MARDI, MPOB, LGM (Malaysia Rubber Board), MCB (Malaysia Cocoa Board), FRIM (Forest Research Institute Malaysia), VRI (Veterinary Research Institute), Sarawak and Sabah Agricultural Departments and FRI (Fishery Research Institute). The secondary data were obtained from the Ministry of Science, Technology and Innovation.

Results and discussion

Background of the respondents (the researchers)

From a total of 3,809 researchers in the public research institutes, 33.50% (1,276) were involved in agricultural research in 2000 (Anon. 2002). The average age and experience of the researchers were 39 years old and 18.8 years respectively. Full-time researchers accounted for 68.45%, whilst the remainders were part-time researchers, spending between 25–75% of their time on R&D activities. According to the academic qualification of the researchers, the majority had M.Sc./M.A.

(48.37%), followed by Ph.D. (28.19%), then B.Sc./B.A. (22.85%) and others (0.59%).

The technical competence versus the level of R&D undertakings by the public research agencies indicated by the respondents were strong (63.80% versus 54.01%), medium (34.42% versus 43.92%), and weak (1.78% versus 2.08%) respectively. Evaluation of respondents in terms of support from top management in R&D undertakings showed that 60.83% were strong, 34.12% medium and 5.04% weak.

Trends in the public sector R&D investment

The trends in the public sector investment in agricultural R&D are as shown in *Table 1*. The substantial increase in R&D expenditure by the public sector in 2000 reflected a strong emphasis and commitment on the development of agricultural technology, in line with the National Agricultural Policy 1998–2010 and the 8th Malaysian Five Year Development Plan (2000–2005).

Technology management

R&D focus

R&D activities undertaken in order of preferences were applied research (74%), basic and fundamental research (41%), socio-economic and marketing (10%) and others (4%). The total was greater than 100% because of overlapping answers.

For idea-generation, the personnel have to be technically competent in one or more fields and have the ability to conceptualise (Jane and Triandis 1990). They must be good with abstract thinking and have a real interest in R&D. The generation of the original idea about R&D was obtained from many sources and listed in order of importance include researcher's own initiative (65.58%), programme leader or director (39.76%), institution's top management (21.36%), colleagues/peer groups (20.77%), private sector/industry (13.54%), Ministry or IRPA panel (10.68%) and others (2.96%).

The determination of potential R&D by the researchers was prompted by several factors. They include solving current problems/ fulfilling current technology needs, future efficiency improvements, future product improvements, fulfill 'just in time' technology requirements, develop data base for future references, improve knowledge for resource management and development. There were several methods used to identify R&D activity potentials in order of importance, such as existence of potential users, fulfill clients' needs, technical advantages over the old technology, fulfill technology gaps, ready market for the R&D outputs, cheaper products, increased efficiencies and minimal adjustment requirement in production facilities.

R&D resources

The funds for R&D expenditures were mainly from IRPA (40.84%), development budget (30.30%), operating budget (15.0%) and external resources such as from the Japanese

Table 1. R&D expenditures and researcher-full time equivalents (FTE) in agriculture in different sectors for years 1992–2000

Item	1992	1994	1996	1998	2000
R&D expenditures (million)					
Public Sector	108	96	58	62	83
Private Sector	24	31	32	29	30
University	10	5	5	8	26
No. of researchers (FTE)					
Public Sector	233	403	229	290	429
Private Sector	60	79	100	78	81
University	92	64	49	70	410

Source: Anon. (2002)

Government, ACIAR, European Union, public sector (20.86%) and others (2.92%).

In general, 82.20% researchers indicated that government agencies and R&D research institutes have qualified and creative human resources. The survey also revealed that 68.75% of the researchers need the pressure of strong communication between other units and the R&D units in a particular agency. Emphasis on technology transfer units to facilitate technology transfers was 74.70% as compared to patenting technology (38.62%).

Goals determine a big proportion of human behaviour (Locke et al. 1981). Motivation to achieve these goals is a major factor in determining researcher performance and organisational effectiveness. For maximal organisational effectiveness, it is important to make these two sets of goals compatible. Factors that motivated researchers towards R&D in order of importance were personal satisfaction, professional reputation, increasing knowledge, recognition by their institutes (rewards and promotions), responsibilities as researchers and consistent with the transformation of the agricultural industry.

Assessments on the management of human resource development for enhancing R&D capabilities within the institution were mainly achieved by long-term trainings (Ph.D./M.Sc.) followed by the in-house trainings, short-term trainings (local/overseas), technical attachments and study visits *(Table 2)*.

Respondents were also asked about the factors influencing R&D capabilities and creativities in their institutions. The survey results showed that the budgets were 16.32% very adequate, 42.43% adequate, 31.41% fair, 7.12% inadequate and 2.67% very inadequate (*Table 3*).

In general, the results from the survey indicated that the majority of the respondents (96.74%) agreed that the private sector should support R&D in the public sector. The following factors, in order of importance, given by the researchers were win-win situation, funding, sharing R&D facilities, commercialisation of technology, technology transfer, better R&D direction, enhanced product and service quality, increased knowledge among researchers, technical

Table 2. Assessments on the management of human resource development towards enhancing R&D capabilities within institutions (%)

Types of training	Strong	Fair	Weak	None
Long-term training (Ph.D./M.Sc.)	48.96	36.42	13.43	1.19
Short-term training (Local/overseas)	28.78	40.65	27.00	3.56
In-house training	22.55	40.95	32.05	4.45
Technical attachment	18.69	37.69	32.34	11.28
Study visit	17.37	35.63	34.73	12.28

Table 3. Factors influencing R&D capabilities and creativities (%)

Resources	Very adequate	Adequate	Fair	Inadequate	Very inadequate
Size of budgets	16.32	42.43	31.41	7.12	2.67
Budget growth	8.61	37.98	38.28	10.98	4.15
No. of R&D personnel	8.31	27.00	36.20	20.77	7.72
Personnel capacity (creativity, innovations, knowledge)	10.68	39.76	37.79	9.79	2.37
Lab/equipment/field	11.87	42.73	31.16	11.87	2.37
Training	5.93	27.00	36.20	23.44	7.42

expertise, solution to private sector problems and avoidance of duplication in R&D.

The possible area of support urgently needed by the public sector, in order of importance, were R&D funding, training R&D personnel, incentives, ability to use private labs/facilities for R&D purposes, marketing information, joint research and dedicated researchers. There were many factors which influenced creativity amongst researchers. The most important factors were recognition and appreciation, followed by freedom to work on areas of great interests, more contacts with inspiring colleagues and others (*Table 4*).

R&D outputs

The degree of success in commercialisation activities was less than 50% (*Table 5*). In general, the output from the R&D activities was mainly transferred directly to the clients. This was followed by results being either disseminated by extension agents, directly applied by the institute, yet to be applied and commercialised or had no takers.

Respondents were also asked to compare research productivity and efficiency between the public sector and private institutions. The survey results indicated that 41.84% researchers agreed that R&D in public sector were more productive and efficient while 21.96% said otherwise. The remainder 36.21% respondents were not sure or did not know.

Public versus private sector R&D

The respondents were asked to evaluate R&D from the public sector against that of private sector, using many criteria such as remuneration, rewards, promotion opportunities for further training, bureaucratic procedures, independence at work, monitoring and evaluation and accountability (Fuglie 1996). The results of the survey showed more than 50% of the respondents indicated remuneration, promotion, bureaucratic procedures, rewards and recognition as worse than those from the private sector *(Table 6).*

It is clear that only the criteria on the opportunities for further training and independence at work were better than the private sector. About 45.70% of the respondents indicated that the public sector was similar with the private sector in terms of work pressure accountability. In general, 22% of the respondents indicated that the public sector was better than the private sector, 25% thought them as similar, 36% felt that the public sector R&D was worse than the private

Table 4. Important factors found necessary in enhancing creativity among researchers (%)

Factors	Very important	Important	Fair	Not important	Not Important at all
Freedom to work on areas of interest	65.58	23.44	8.51	1.78	0.58
Recognition and appreciation	70.92	18.69	8.31	0.50	1.48
More contacts with inspiring colleagues	56.68	32.34	9.50	10.19	0.30
Encouragement to take risk	32.74	36.61	21.43	8.04	1.19
Tolerance of non-conformity by superiors	26.71	33.83	31.45	6.23	1.78
Monetary rewards	32.05	35.01	22.55	7.42	2.97
Opportunity to work alone rather than in a team	5.64	10.98	40.65	25.32	17.21
Creative training programmes	36.20	32.64	23.15	6.53	1.48
Criticism by supervisors or associates	17.51	38.28	33.23	7.42	3.56
Regular performance appraisal	24.40	38.10	29.46	6.25	1.79
Targets as evaluation measures for success	43.92	32.94	17.21	3.26	2.67

Table 5. The degree of project success versus what was planned (%)

Goal	Unsuccessful	Less than 50%	More than 50%	Very successful
Fulfill project objective	–	5.06	64.29	30.65
Within financial allocation	–	7.16	66.87	25.95
Within the time frame	1.20	14.07	65.57	19.16
Commercialisation activities	18.41	49.52	26.35	5.71

Table 6. Public sector assessment of some selected performance criteria against those from the private sector (%)

Criteria	Better than private sector	Same with the private sector	Worse than private sector	Unsure
Remunerations	2.37	13.65	65.88	18.10
Rewards and recognitions	11.57	19.29	51.34	17.80
Promotions	10.68	18.40	55.19	15.73
Opportunities for further training	50.45	16.91	21.96	10.68
Bureaucratic procedures	6.25	22.02	51.79	19.94
Independence at work	48.96	26.11	8.61	16.32
Monitorings and evaluations	16.32	38.87	23.44	21.37
Accountabilities	30.56	45.70	11.87	11.87

sector while about 17% of the respondents were not sure.

In general, the survey revealed that R&D activities by the public sector are less productive and less efficient when compared to the private sector, as indicated by the higher percentage of technology not yet applied and commercialised (35%) or without takers (10%). Some of the lessons which could be emulated from the survey findings were:

- **R&D findings**
  Past studies showed that the poor uptake of R&D findings was due to problems in project identifications and poor interactions with potential end-users. In most R&D undertakings, the involvement of potential users was lacking at all stages of the technology generation cycle. Hence, failures to clearly identify the potential clients from the very beginning were the more likely reasons that the outputs of the project were not adopted. Thus, many R&D outputs became irrelevant to farmers' needs.

- **R&D management**
  To some extent, decisions on research priorities are made based on strong information on their market potentials. However, the components of technology uptake or commercialisation were secondary and were not given similar emphasis. In fact, in some institutions these activities were assigned to other institutions or departments.

- **R&D environments**
  Successful R&D undertakings and their subsequent utilisations were partly due to the conducive environments that the researchers were provided with. The physical environments were comparable and to some extent lower than those of the private sector. Thus, there is a need for the public sector R&D to be managed in a more flexible manner. It need not has to be subjected to the rigid civil service guidelines which in some cases are not complementary to a creative and conductive for a R&D environment. Research findings revealed that researchers from the public sector were worse than those from the private sector, in terms of remunerations, rewards and recognition, promotion and bureaucratic procedures.

Recommendations and policy options

To strengthen the national R&D capabilities, the government policy should ensure that the public sector R&D complement and be supportive of the role played by the private sector. Some of the recommendations are as follows:

- R&D linkages between public and private sectors should be strengthened by exploiting potentials for sharing of resources such as joint research, job attachments and trainings, accessibilities to laboratories, equipment and research fields, and contract research. Hence, joint-research between public and private sectors is the most important form of R&D linkage that can be given by the public sector R&D to private R&D institutions.

- Accessibilities of IRPA funds to the private sector are another requirement that it strongly recommended. The opening up of this facility to the private sector, with possibilities for joint-research, could enhance the cooperation of the public and private sectors R&D.

Conclusion

Thus, a more efficient management of R&D to increase the degree of commercialisation in the public sector R&D should be given priority in the future. The strengthening of R&D capabilities as the driving force to ensure a competitive agricultural sector has consistently been the agenda of the country. This is consistent with NAP3 and the ability of the agricultural sector to compete globally. It should be ensured that the transferring and adoption of research outputs are taking place and the public sector R&D activities be truly demand driven.

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Abstrak

Satu kajian terhadap para penyelidik di agensi dan institusi penyelidikan dan pembangunan (P&P) pertanian awam telah dijalankan pada tahun 2004. Kajian ini bertujuan untuk menerangkan, menggambarkan dan menilai mekanisme dan struktur semasa P&P pertanian di sektor awam. Sejumlah 337 orang penyelidik dari agensi tersebut telah dipilih dengan kaedah pensampelan berlapis. Data primer diperoleh dengan kaedah survei menggunakan borang soal selidik yang mempunyai soalan berstruktur secara temu bual bersemuka dan juga melalui pos. Penemuan kajian menunjukkan pada tahun 2000, terdapat 33.50% (1,276 orang) yang terlibat dalam penyelidikan pertanian. P&P yang diutamakan ialah penyelidikan gunaan, *fundamental* dan asas, sosioekonomi dan pemasaran. Pertambahan perbelanjaan dalam P&P oleh sektor awam pada tahun 2000 menggambarkan penekanan dan komitmen kerajaan dalam pembangunan teknologi pertanian selaras dengan Dasar Pertanian Negara 1998–2010. Sebanyak 74.70% responden menyatakan pewujudan unit pemindahan teknologi untuk mempercepat pemindahan teknologi lebih

diperlukan berbanding 38.62% responden yang mahu mempatenkan teknologi. Seterusnya bidang yang memerlukan sokongan segera oleh sektor P&P di sektor awam ialah pembiayaan kewangan, latihan, penggunaan makmal swasta, maklumat pasaran dan penyelidik yang berdedikasi. Peratus output P&P yang dipindahkan secara langsung kepada pelanggan ialah 50.15% diikuti oleh agen pengembangan 41.25%, penggunaan langsung oleh institusi 35.61%, masih tidak digunakan dan dikomersialkan 35.01% dan tiada pelanggan 9.50%. Penemuan kajian juga menunjukkan kebanyakan penyelidikan yang dilaksanakan tidak mengambil kira pelanggan yang berpotensi pada peringkat permulaan P&P dan ini akan memberi kesan kepada penerimaan guna atau pengkomersialan output P&P. Bagi menguatkan lagi keupayaan P&P, polisi kerajaan perlu memastikan P&P di sektor awam menjadi pelengkap dan memberi sokongan kepada P&P di sektor swasta.