Seed priming boosts legume crops in South Asia

RIU

Validated RNRRS Output.

Poor farmers in Bangladesh, India and Nepal have seen for themselves how easy it is to get better crops of legumes by simply priming the seed before sowing. Because legume seeds are large and hard to store properly, and are sown in the poorest soils, no-one has paid much attention to improving the way they are grown. But legumes provide valuable protein for the poor. Farmers in Bangladesh, eastern India and Nepal, now prime chickpea seed so they can grow it as an extra crop following rice. Lentil seed is being primed in Nepal, and mungbean in Nepal and Pakistan. As priming is so simple and farmers quickly reap the benefits, the potential for widespread use is huge.

Project Ref: **PSP26:**
Topic: **1. Improving Farmers Livelihoods: Better Crops, Systems & Pest Management**
Lead Organisation: **CAZS-NR, UK**
Source: **Plant Sciences Programme**

Document Contents:

Description

PSP26

Research into Use
NR International
Park House
Bradbourne Lane
Aylesford
Kent
ME20 6SN
UK

Geographical regions included:

Bangladesh, India, Nepal, Pakistan,

Target Audiences for this content:

Crop farmers,

A. Description of the research output(s)

1. Working title of output or cluster of outputs.
In addition, you are free to suggest a shorter more imaginative working title/acronym of 20 words or less.

Seed priming for legumes in S. Asia

2. Name of relevant RNRRS Programme(s) commissioning supporting research and also indicate other funding sources, if applicable.

Plant Sciences Research Programme (PSP)

3. Provide relevant R numbers (and/or programme development/dissemination reference numbers covering supporting research) along with the institutional partners (with individual contact persons (if appropriate)) involved in the project activities. As with the question above, this is primarily to allow for the legacy of the RNRRS to be acknowledged during the RIUP activities.

R6395, R7438

UK
CAZS Natural Resources, Bangor UK (Dr Dave Harris)

India
Gramin Vikas Trust (West), Jhabua, India (Mr B.S Raguwanshi)
Gramin Vikas Trust (East), Ranchi, India (Mr V.K. Vij)

Nepal
FORWARD, Chitwan, Nepal (Mr N. N. Khanal)
LI-BIRD, Pokhara, Nepal (Dr P. K. Shrestha)

Pakistan
NWFPAU, Peshawar, Pakistan (Prof A. Rashid)

Bangladesh
PROVA, Rajshahi, Bangladesh (Mr A. M. Musa)

*4. Describe the RNRRS output or cluster of outputs being proposed and when was it produced? **(max. 400 words)**. This requires a clear and concise description of the output(s) and the problem the output(s) aimed to address. Please incorporate and highlight (in bold) key words that would/could be used to select your output when held in a database.*

Farmers need a field full of plants to have any chance at all of getting a reasonable yield, yet good crop stands are often the exception rather than the rule for poor farmers. In marginal, rainfed areas, **patchy plant stands** often result from the failure of the crop to emerge quickly and uniformly. Yields of many crops are reduced because not enough seeds germinate and the plants that eventually emerge do so slowly and are susceptible to drought, pests and diseases. This is a particular problem for **legumes** because seeds are large, often difficult to store properly and so quality is compromised, and because legumes are often sown in sub-optimal conditions on land more suited to the requirements of the predominant crops such as rice, maize etc. Although legumes are valuable sources of protein, and in some circumstances can be quite lucrative, they seldom receive the care, attention and physical resources lavished on the staple cereals.

On-farm seed priming is a simple, low-cost, low-risk technology that hastens germination and seedling emergence and promotes vigorous early growth so that transient resources (soil moisture, nitrogen, etc.) are captured and utilised. Seed priming simply involves soaking legume seeds in water, usually for 6-8 hours or ‘overnight’, surface-drying them to facilitate easy handling, then sowing them in the normal fashion.

Legume plants (**chickpea, lentil, mungbean, horsegram**) grown from primed seeds generally emerge earlier and in greater numbers, grow more vigorously, flower and mature earlier and often yield better than those from non-primed seeds. The technology was developed, tested, refined and promoted using a combination of *in vitro*, on-station and **participatory action research** with farmers in **Bangladesh**, **India**, **Nepal** and **Pakistan** during the period 1996-2006 but is appropriate wherever legumes are grown.

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5. What is the type of output(s) being described here?
Please tick one or more of the following options.

Product	***Technology***	***Service***	***Process or Methodology***	***Policy***	***Other Please specify***
	X				

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6. What is the main commodity (ies) upon which the output(s) focussed? Could this output be applied to other commodities, if so, please comment

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Rainfed grain legumes (see Q4) are the main focus but the technology is also applicable to other legumes and other crops, both rainfed and irrigated, under particular circumstances. Seed priming has been tested elsewhere in a range of other crops, the results of which are the subjects of other RIUP dossiers - see PSP dossiers:

- Seed priming upland rice in W. Africa and S. Asia;
- Seed priming in wheat, barley, sorghum, pearl- and finger millet in South Asia and Africa;
- Seed priming in maize in Asia and Africa;
- 'On-farm' seed priming to improve disease resistance in mungbean, chickpea and pearl millet;
- 'On-farm' seed priming to improve plant nutrition in low fertility soils

Seed priming, including all work funded by PSP has been reviewed recently by Harris (2006)

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7. What production system(s) does/could the output(s) focus upon?
Please tick one or more of the following options. *Leave blank if not applicable*

Semi-Arid	High potential	Hillsides	Forest-Agriculture	Peri-urban	Land water	Tropical moist forest	Cross-cutting
x							x

8. What farming system(s) does the output(s) focus upon?
Please tick one or more of the following options (see Annex B for definitions).
Leave blank if not applicable

Smallholder rainfed humid	Irrigated	Wetland rice based	Smallholder rainfed highland	Smallholder rainfed dry/cold	Dualistic	Coastal artisanal fishing
x	x	x	x	x		

*9. How could value be added to the output or additional constraints faced by poor people addressed by clustering this output with research outputs from other sources (RNRRS and non RNRRS)? (**max. 300 words**).*

Please specify what other outputs your output(s) could be clustered. At this point you should make reference to the circulated list of RNRRS outputs for which proformas are currently being prepared.

Seed priming addresses a fundamental requirement for crop production – the need to have a field full of vigorous plants. As such, the technology can be incorporated with almost any other technology or process that can be used to improve crop performance. Integrative approaches to agricultural development, such as IPM, ICM or ICNM are particularly appropriate.

The participatory action research used to develop and validate this output (see section 10) is appropriate in situations where farmers are testing new varieties for themselves. The benefits of seed priming are effectively demonstrated to good effect in: PSP, Rice fallow rabi cropping systems, R8098, R8221, R8269; PSP, Rainy season legume varieties for India; PVS, Generic theme. Other useful linkages could be made with, e.g. CPP, Chickpea ICM, R8427, R8366, R7885 and LPP, Cultivation of African *dhaincha* and fodder *khesari* as animal feed in rice fields, R6610.

Value could be added in low fertility soils by linking with PSP, On-farm seed priming to improve plant nutrition in low fertility soils, R7438, R8221, R8269.

Validation

B. Validation of the research output(s)

*10. **How** were the output(s) validated and **who** validated them?*

Please provide brief description of method(s) used and consider application, replication, adaptation and/or adoption in the context of any partner organisation and user groups involved. In addressing the "who" component detail which group(s) did the validation e.g. end users, intermediary organisation, government department, aid organisation, private company etc... This section should also be used to detail, if applicable, to which social group, gender, income category the validation was applied and any increases in productivity observed during validation ***(max. 500 words)****.*

One hundred and one farmers in 17 villages in Rajasthan, Gujarat and Madhya Pradesh states in **India** tested priming in **chickpea** during the 1995-96 and 1996-97 *rabi* seasons. Almost all farmers reported earlier emergence (by 2-3 days) and better, more uniform stands that withstood drought better than non-primed crops (Harris *et al*., 1999). Priming accelerated flowering (by 7-10 days) and the formation of pods. Crops matured earlier, by about 7-10 days and yields were higher. Independent corroboration by researchers of 10 trials in Bar, Gujarat and 8 trials in Bihar village, Madhya Pradesh showed mean advances in maturity of 7.6 days and 6.7 days, respectively, while yield increases due to priming were 45 % in Bar and 15 % in Bihar village.

Musa et al. (2001) facilitated 280 farmers between 1998 and 2002 to compare primed- with non-primed chickpea after the harvest of *aman* (rainy season) rice in the High Barind Tract of **Bangladesh**. In farmer-implemented, paired-plot trials, priming chickpea seeds for 8 h increased yield significantly by 47 % in 1998-99, by 20% in 1999-00, 35% in 2000-01 and 40% in 2001-02. Priming also increased mean yield by 17 % in 15 researcher-managed demonstration trials in 1998-99. Emergence, early growth and plant stand at harvest were increased by about 20 %, height at harvest by 10 %, the number of pods m^{-2} by 25 %, 1000-grain mass by about 5 %, stover yield by 20 %. Root nodules per plant were counted in 1999-00 and primed plants had 48 % more nodules than did non-primed plants.

Priming **mungbean** seeds for 8 h before sowing was tested in 15 irrigated on-station trials and four sets of rainfed, paired-plot, farmer-participatory trials over four contrasting years from 1999 to 2002 in the North West Frontier Province of **Pakistan** (Rashid *et al*., 2004). Priming gave a mean yield increase of 56 % and was better than not priming in all trials. In farmers' fields over four years, yields were proportional to rainfall but primed seed outperformed non-primed seed in 34 out of 39 trials. Overall mean yield advantage due to priming was 33 % and benefits from priming were the result of a combination of faster germination and emergence and more vigorous growth and development, leading to better crop stands and bigger, more productive plants.

For **horsegram**, soaking seeds for 8 h before sowing increased emergence and final stand by 11% and grain yield by 10% averaged over seven varieties and three years in Jharkhand, eastern **India**. Soaking advanced flowering by 1.3 d and maturity by 1.9 d. All varieties responded positively to soaking and did so in all three years, although the response was stronger in drier years (Virk et al., 2006).

Neupane (2002) tested the effect of priming **lentil** seeds on growth and yield in two on-station trials following rice in Nepalgunj, **Nepal** in 1998-99 and 1999-00. Soaking seeds for 12 h, followed by drying in the shade for 2 h, was the best combination and significantly reduced the time for emergence from 9.5 to 8.2 days in 1998-99 and from 9.3 to 7.4 days in 1999-00. Although stand density was increased, on average, by about 16 %, the effect was not statistically significant. Grain yield was significantly increased by 31 % in 1998-99 and by 37 % in 1999-00. Several hundred farmers at nine sites of three western mid-hill districts (Gorkha, Myagdi and Palpa) tested priming in lentil and around 90% of them reported earlier emergence and higher yields. Ninety percent of farmers intended to continue priming lentil.

*11. **Where and when** have the output(s) been validated?*

*Please indicate the places(s) and country(ies), any particular social group targeted and also indicate in which production system and farming system, using the options provided in questions 7 and 8 respectively, above **(max 300 words)**.*

Legume seed priming has been validated by farmers and researchers in:

- tribal areas of Rajasthan, Gujarat and Madhya Pradesh, India (semi-arid, smallholder, rainfed dry, 1995-1997);
- Jharkhand state in India (semi-arid, smallholder, rainfed dry, 2002-2004);
- five districts (Banu, Mardan, Kohat, Karak, Peshawar) of North West Frontier Province in Pakistan (semi-arid, smallholder, rainfed dry and high potential, irrigated,1999-2004).
- Western mid-hills districts (Gorkha, Myagdi and Palpa) of Nepal (hillsides, smallholder, rainfed dry, 2003-2005) and in Banke district in the *Terai* (wetland rice-based, smallholder, rainfed dry, 1998-2000)
- the HBT of Bangladesh (semi-arid, smallholder, rainfed dry, 1998 – 2002).

Current Situation

C. Current situation

*12. **How and by whom** are the outputs currently being used? Please give a brief description **(max. 250 words)**.*

Chickpea priming is being used widely by resource-poor farmers in Bangladesh, eastern India and in Nepal within initiatives to promote chickpea as a second crop after rainfed rice. Mungbean is also being primed in Nepal under the same initiative and also by some farmers in Pakistan. Lentil priming has been adopted as a recommended practice in Nepal (Koirala and Ghimire, 2005) and farmers in the western mid-hills and eastern *Terai* are using it. Horsegram priming has not been promoted at all and, to our knowledge, no farmers are using it.

*13. **Where** are the outputs currently being used? As with Question 11 please indicate place(s) and countries where the outputs are being used **(max. 250 words).***

In Bangladesh, Saha (2002) and Socioconsult (2006) only surveyed the impact of chickpea promotion (including seed priming) in the High Barind Tract (Rajshahi, Chapai Nawabganj and Naogaon districts) where development and validation of the technology took place, although there may have been some wider diffusion. In India, more than 10000 households in Madhya Pradesh, Uttar Pradesh, Chhattisgarh, Jharkhand, Orissa, W. Bengal and Maharashtra states are growing chickpea using seed priming as part of the package (Kankal, 2006).

Lentil is being primed in at least three mid-hill districts (Gorkha, Myagdi and Palpa) and in two *Terai* districts (Siraha and Saptari) in Nepal.

Some farmers in five districts (Banu, Mardan, Kohat, Karak, Peshawar) of North West Frontier Province in Pakistan are priming mungbean, as are farmers in Kapilbastu, Saptari and Jhapa districts of Nepal.

14. What is the scale of current use? Indicating how quickly use was established and whether usage is still spreading ***(max 250 words).***

Saha (2002) indicated rapid adoption of priming technology in the HBT of Bangladesh in response to project activities. Given the simplicity of the technology and the ease with which farmers can test it for themselves, further spread depends on how many new farmers can be exposed to the technology, either through formal channels (proactive promotion by GOs and NGOs) or by farmer-to-farmer spread. Similar considerations apply to chickpea and mungbean in Nepal.

The national presence of CRS in India and the ability to access resources from other players has allowed promotional activities to continue on an expanding scale in nearly 900 villages during the 2006-2007 season. The Chhattisgarh state government is also committed to its own programme promoting rainfed *rabi* cropping that includes seed priming. Both should result in increased adoption.

15. In your experience what programmes, platforms, policy, institutional structures exist that have assisted with the promotion and/or adoption of the output(s) proposed here and in terms of capacity strengthening what do you see as the key facts of success? ***(max 350 words).***

Close linkages and mutual respect between the NGOs and government line agencies (e.g., FORWARD/ NARC / DADOs in Nepal; CRS/ State Departments of Agriculture / State Agricultural Universities in India; PROVA / Department of Agricultural Extension / BARI / BRRI in Bangladesh) have been essential in developing and promoting seed priming successfully. In contrast, in Pakistan where work was done predominantly by a University without strong links to community-focused organisations, uptake of the technology has been weak despite strong technical evidence of validation.

It must be acknowledged, however, that NWFPAU Pakistan has been the source of much of the technical innovation in seed priming that has been disseminated successfully in the other countries. Feedback and interaction, including reciprocal visits, between Bangladesh, India, Nepal and Pakistan have been very effective in the successful development of legume seed priming.

Current Promotion

D. Current promotion/uptake pathways

16. ***Where*** *is promotion currently taking place? Please indicate for each country specified detail what promotion* *is taking place, by whom and indicate the scale of current promotion* ***(max 200 words).***

Promotion is being continued by the original NGO partners (CRS, PROVA, FORWARD) in all three countries to the best of their abilities without external funding.

In Bangladesh, promotion involving demonstrations is still mainly in the HBT, by the NGO PROVA and DAE. There is scope for uptake of the technology for onward extension by other NGOs and more widely throughout DAE.

In India, CRS is committed to an ambitious plan of expansion involving promotion of the technology in nearly 900 villages during the 2006-2007 season. The Chhattisgarh state government, following a joint workshop in Raipur with CRS and the National Bank for Agriculture and Rural Development (NABARD) also plans its own promotion programme in 2006-2007.

CAZS-NR maintains a website (www.seedpriming.org) and responds to requests for information on seed priming on an ongoing basis. Information provided includes general information on priming including legumes, reprints of published papers and tailored protocols for participatory testing of priming specific to the nature of the enquiry. We have also distributed several thousand copies of two colour brochures (DFID/PSP 2001; 2006) to interested parties at international conferences and by post. Seed priming has also been widely promoted during conference presentations around the world and at dedicated Technology Fairs (in Zimbabwe in December 2005 and in Uganda in February 2006).

17. What are the current barriers preventing or slowing the adoption of the output(s)? Cover here institutional issues, those relating to policy, marketing, infrastructure, social exclusion etc. ***(max 200 words)****.*

In general, programmes are necessary to increase the exposure (of farmers and of institutions that provide support to farmers) to the potential benefits of priming seeds. Once ‘demand’ for the output is established, simple participatory action research techniques can be used to train and facilitate farmers to test priming for themselves.

In Bangladesh, as in India and Nepal, NGOs and GOs (e.g., DAE and NARS) are well placed and well equipped for further promotion but concerted and focussed efforts are needed. An assessment of priming needs for other crops is required such that entire cropping system priming recommendations can be established. The Bangladesh Agricultural Research Institute did initiate some work on priming of alternative crops to chickpea but this was not adequately followed up. There is a need to define the circumstances under which each crop does or does not require priming, and the optimum method of priming for each crop. As the technique is so cheap and simple, with high potential returns in defined circumstances, it should be an attractive extension proposition for NGOs and GOs.

18. What changes are needed to remove/reduce these barriers to adoption? This section could be used to identify perceived capacity related issues ***(max 200 words).***

Given the simple nature of the technology, awareness of farmers could be raised using TV, radio or poster campaigns, linked to an increased capacity of appropriate GOs and NGOs to provide advice on seed priming if it is subsequently requested. In parallel, seed priming could, with some training of trainers, be incorporated into the mainstream extension and rural development programmes of GOs and NGOs. The ultimate barrier is, of course, limited resources.

19. What lessons have you learnt about the best ways to get the outputs used by the largest number of poor people? ***(max 300 words).***

Directly involving farmers, researchers and extension agents in the evaluation of the technology is the best way to get seed priming used by as many poor people as possible. Participatory action research (PAR) allows farmers to test priming for themselves, to see how it performs in a variety of situations (by observing their neighbours efforts) and to provide feedback (problems, possible solutions, improvements, etc) to all collaborators. PAR thus has a dual research/extension function. Information on, and opportunities for trying, seed priming are best supplied through close collaboration between farmers and extensionists working together to improve the whole farming system rather than isolated elements of it.

One of the best ways to get seed priming technology to a large number of farmers is to link the technology to a PVS programme. Experience has shown that farmers are generally very keen to try new varieties and, by giving improved legume cultivars to farmers and asking them to prime some of the seeds, they can see the direct and indirect effects for themselves, thus leading to adoption.

Impacts On Poverty

E. Impacts on poverty to date

20. Where have impact studies on poverty in relation to this output or cluster of outputs taken place? This should include any formal poverty impact studies (and it is appreciated that these will not be commonplace) and any less formal studies including any poverty mapping-type or monitoring work which allow for some analysis on impact on poverty to be made. Details of any cost-benefit analyses may also be detailed at this point. Please list studies here.

Two studies have considered the usage of seed priming for chickpea in Bangladesh:

- Saha, A.K. (2002). Impact assessment study for the DFID-funded project R7540 ‘Promotion of Chickpea following Rainfed Rice in the Barind Area of Bangladesh’. CAZS Natural Resources, University of Wales, Bangor, UK.

- Socioconsult (2006). Report on Impact Assessment Study of Chickpea in the High Barind Tract (HBT). Socioconsult Ltd., SEL Centre, 29 West Panthapath, Dhanmondi, Dhaka.

Two other studies consider impacts of packages that include seed priming of legumes but do not expressly consider its contribution:

- Gauchan, D., Khanal, N., Khanal, N.P., Thapa, S. and Joshi, K.D. (2005). Assessment of the Outcomes of Rainfed Rabi Cropping (RRC) Project in Nepal Terai. FORWARD, Chitwan, Nepal.

- Kankal, M., Basu, I., Gupta, B., Mishra, K., Gupta, A., Peter, R. and Dash, P. (2006). Agricultural Alternatives - Experiences of Rainfed Rabi Cropping in Rice fallows of India. Catholic Relief Services-USCCB, October 2006. pp 33.

21. Based on the evidence in the studies listed above, for each country detail how the poor have benefited from the application and/or adoption of the output(s) ***(max. 500 words):***

- *What positive impacts on livelihoods have been recorded and over what time period have these impacts been observed? These impacts should be recorded against the capital assets (human, social, natural, physical and, financial) of the livelihoods framework;*
- *For whom i.e. which type of person (gender, poverty group (see glossary for definitions) has there been a positive impact;*
- *Indicate the number of people who have realised a positive impact on their livelihood;*
- *Using whatever appropriate indicator was used detail what was the average percentage increase recorded*

Based on a survey of 75 farmers, Saha (2002) reported that, after 3 years of project activity in promoting seed priming in the HBT, 60% of all chickpea was sown using primed seed. All farmers questioned either thought that priming was becoming more common (54%) or could not discern a trend (46%). Average yield increases due to priming were almost 40%, in good agreement with increases measured during earlier validation exercises (see Q10). Although benefit: cost ratios for seed priming were not calculated for seed priming, marginal rates of return will be very high indeed because of the extra yield obtained without significant extra cost.

Benefits from seed priming are open to all farmers who grow, or wish to grow, legumes and are the result of improved productivity and profitability. It requires no special equipment or heavy manual labour so poor men and women can use it. Socioconsultant (2006) reported that chickpea and seed priming had become a popular crop with farmers in the HBT of Bangladesh and made significant contributions to family incomes and wellbeing.

Environmental Impact

H. Environmental impact

24. What are the direct and indirect environmental benefits related to the output(s) and their outcome(s)? ***(max 300 words)***

This could include direct benefits from the application of the technology or policy action with local governments or multinational agencies to create environmentally sound policies or programmes. Any supporting and appropriate *evidence can be provided in the form of an annex.*

Growing legumes has many positive effects on the environment as a result of their ability to fix atmospheric nitrogen. Legumes are known to enrich the soil and reduce its tendency to erode. Legumes as alternatives to bare fallow (e.g. chickpea after rice) also cover the ground for longer and minimise erosion. If priming increases the growth and yield of legumes, these benefits will be enhanced. In some circumstances, priming makes the difference between being able to grow a crop and not doing so.

25. Are there any adverse environmental impacts related to the output(s) and their outcome(s)? ***(max 100 words)***

No adverse environmental impact is envisaged.

26. Do the outputs increase the capacity of poor people to cope with the effects of climate change, reduce the risks of natural disasters and increase their resilience? ***(max 200 words)***

Priming legumes increases the resilience of the poor through reduction of cropping risk and allowing higher and more stable yields.

Apart from increased profitability as a result of higher yields, additional livelihood choices, such as the opportunity to migrate earlier or to plant an additional crop more successfully, increase the resilience of poor people

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Annex

References

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DFID/PSP (2006). *'On-Farm' Seed Priming. A key technology to improve the livelihoods of resource-poor farmers in marginal environments*. Second edition. DFID/PSP information booklet, English language version. Centre for Arid Zone Studies, University of Wales, Bangor, UK, pp 20.

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Harris, D., Joshi, A., Khan, P.A., Gothkar, P. and Sodhi, P.S. (1999). On-farm seed priming in semi-arid agriculture: development and evaluation in maize, rice and chickpea in India using participatory methods. *Experimental Agriculture* 35: 15-29.

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Rashid, A., Harris, D., Hollington, P.A. & Rafiq, M. (2004). Improving the yield of mungbean (*Vigna radiata*) in the North West Frontier Province of Pakistan using on-farm seed priming. *Experimental Agriculture* 40 (2): 233-244.

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Virk, D.S., Chakraborty, M., Ghosh, J. and Harris, D. (2006). Participatory evaluation of horsegram (*Macrotyloma uniflorum* Lam Verdc.) varieties and their on-station response to on-farm seed priming in eastern India. *Experimental Agriculture* 42: 411-425.